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The Dock & Harbour Authority

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Editorial Comments

The Port of Toronto.

The Toronto Harbour Commissioners Act was passed by the Dominion Government on May 19th, 1911, and provided for the appointment of five Commissioners, three of them being nominated by the Toronto City Council and two by the Government, one of whom represents the Board of Trade.

With this Board of Commissioners or directors it was to be expected that some far-sighted proposals would be put into operation, based not only upon fostering the prosperity of the port itself, but upon the attraction of suitable industries to the harbour area, the amenities of the city and the pleasure and well-being of its inhabitants.

The result of working to the comprehensive progressively planned development scheme evolved by the Board of Commissioners is outstanding and the composition of the Board and its policy might well be studied in Great Britain in the formation of new Port Authorities under the Nationalisation of Transport.

Toronto is, of course, in a singularly stragetic position. Lying on the north shore of Lake Ontario it is a great railway centre connecting Canada's two trans-continental railways with the United States Railway which serves the Northern States of the American Union, moreover, ships from European, Canadian and United States Ports, now make Toronto a port of call, and it is envisaged that in the future the harbour facilities will give service to ocean carriers which will pass through a completely modernised Great Lakes-St. Lawrence waterway, with a navigable depth of 30-ft.

One of Canada's finest highway systems also enables transportation of freight direct from the docks to any part of the surrounding country.

In our issue of December, 1921, we published an article by Mr. E. L. Cousins, Chief Engineer and Manager, Toronto Harbour, descriptive of the works constructed since 1911 and in hand up to 1921. Our readers will therefore be pleased to now have the opportunity of studying a comprehensive review of the continued expansion and development of the port up to the present date, contributed by the same writer.

From shallow waters, marshlands and swamps, the Harbour Commissioners have succeeded in forming a completely modernised port, comprising upwards of 50,000 lineal feet of berthing space, some 900 acres of industrial and manufacturing sites, a large air port and seaplane base, cold storage, dry storage and transit sheds of ample capacity, facilities for grain storage, oil storage and refining and coal handling, besides the special amenity features of parks and recreation areas, etc., above alluded to.

Dealing with constructional engineering the author describes the modernised constructional details of the main dock walls. The basis of design, however, still remains that of the round timber piled type and crib type of wall which are a common feature of a large number of such structures in the western ports of the North Atlantic Coast of the American Continent, due to the large supplies of timber available.

Where, however, the depth to the rock, which appears to cover most of the harbour sites, is lower than 40-ft. steel sheet piling is incorporated in the design.

Mr. Cousins review of the Toronto Harbour works will be read with interest alike by dock engineers and port administrators and we are hoping that in the future we shall be able to give some account of the special cargo-handling and other mechanical equipment with which the port is furnished.

The Heysham Jetty.

In our issue of August last we published the first instalment, necessarily abbreviated by considerations of space, of a paper read before the Maritime and Waterways Engineering Division of the Institute of Civil Engineers, by Prof. A. L. Baker, M.I.C.E., describing the construction of the Heysham Jetty.

We are now able to present in full the Discussion on the paper, the main interest in which centred around the unique design of the flexible "Bell" dolphins and the use of special "fulcrum" hanging fenders.

The former, spaced to take the larger vessels, appear to have given entire satisfaction under varying conditions of sea, wind and impact, while ships of smaller dimensions berthed against hanging fenders on the jetty head between the dolphins with ease and security.

The use of fulcrum fenders in docks or at quays subject to rough water and high winds when vessels discharge cargoes other than oil and the like pumped commodities, that is to say, where "ranging" of the ships is not permissible, was referred to by one member as having possible difficulties unless the fenders could be locked, an opinion with which we concur—but which appears to be a problem not insoluble by simple means.

An alternative form of fulcrum fender was described by Mr. Johnson, which merits consideration and incidentally overcomes the above-mentioned possible difficulty.

Another point that arose in the discussion on the paper was the very great difference between the resistance to driving, of the test piles and that of uplift—about 10-1.

This was explained by the Author as due to sandy silt in the clay and considerable depths of silt and fine sand overlying the blue clay together with the possibility that the test piles were not entirely in the clay.

In this connection we are able to print certain test bores and test pile data from Mr. Baker's paper which illustrates the discrepancy discussed and which will enable readers to examine the matter for themselves.

Editorial Comments—continued

It is unfortunate that owing to the time factor and the urgency of proceeding expeditiously with this war emergency work, no further test piles were possible, because data on this point would have been of considerable interest.

If, after a lapse of several weeks, it had been possible to apply extraction tests on such piles, it seems clear that some further data would have been secured which would have gone far towards elucidating this very interesting problem that appears to have exercised the minds of several engineers present at the discussion.

In conclusion, we draw attention to the remarks of members upon impact, the maximum berthing velocities which should be regarded as reasonable to provide for in designing together with energy absorption of marine structures. As was mentioned in our editorial comments in the August issue, these questions are still largely unsolved and merit further research.

Goodwin Sands.

The dangerous character of the sands off the Kentish Coast has long been appreciated and the note on this which is produced elsewhere in this issue should be of general interest to shipowners. Contrary to popular belief these sands are not "quick." In fact there are even patches of gravel, but not enough to justify the general idea that large masses of shingle migrate eastwards under the combined effect of the prevalent S.W. wind and superior flood currents. The desirability of constructing a lighthouse there has long been realised and even reclamation has been spoken of, but the difficulties are quite serious. In modern times a great deal of information as to currents and changes of depth has become available, but still there are accidents on these sands and any further information will be of great value. It seems clear that some of the accidents might have been avoided. The regime of the tides in this vicinity is of great interest and complexity, owing to the oscillation of the sea between the Coasts of England and those of the Low Countries. Presumably also these sands form a relic of the bridge which once united England with the Continent. The silting up of the Sandwich area, although partly originating from the land, is also associated.

Lloyd's Register Shipbuilding Returns.

The statistics issued by "Lloyd's Register of Shipping" regarding merchant vessels under construction at the end of June last show that in Great Britain and Northern Ireland there is an increase of 105,668 tons in the work in hand as compared with the figures for the previous quarter. The present total of 2,243,703 tons has not been exceeded since December, 1921, when the total was 2,638,679 tons. It is to be remembered, however, that the tonnage of vessels under construction continues to be influenced by the delays which present circumstances are imposing upon the completion of ships, and the consequent prolongation of the time required for building them. In this connection there have of late been many adverse criticisms of the unsatisfactory manner in which the steel quota is being administered, and it is claimed the quota allotted to shipbuilding is steadily being reduced, in spite of the recent phenominal increase of output in the steel industry.

The continued increase in the tonnage intended for registration abroad or for sale is a satisfactory feature of the latest returns, and further emphasises the need for an increase in the allocation of raw materials to the industry. The figure for foreign account has risen progressively from about 100,000 tons at the end of March, 1946, and now stands at 711,455 tons, or 31.7 per cent. of the tonnage being built in this country, and includes 253,446 tons for Norway, and 88,545 tons for Argentina.

The tonnage of merchant vessels under construction abroad at the end of June is 1,778,186 tons gross, which is 3,153 tons less than that recorded at the end of March last, when it was noted that no figures were included for Germany, Japan and Russia. These reservations still apply.

The total tonnage of steamers and motorships under construction in the world (apart from those countries excluded, as mentioned above) amounts to 4,021,889 tons gross, of which 55.8 per cent. is being built in Great Britain and Northern Ireland, and 44.2 per cent. abroad.

Deterioration of Timber Structures.

Until recent times all the lighter seashore structures, like ships themselves, were made of timber. Immense efforts were made to prolong the life of such structures, without marked success except when rare and foreign woods were used. Creosoting under pressure has proved a partial cure for deterioration of soft timbers. For thirty two years this has been the subject of study by the Institution of Civil Engineers and on a following page will be found a review of the latest report on the subject. Chemistry, biology, meteorology, mechanics and economics are all involved. The matter is of especial interest at the present time when there is so much reconstruction to be done at the very moment when materials are difficult to get. Decay occurs between low and high water but marine borers take up the role at lower levels. Both act most at the places where injury is mechanically most objectionable, and means of resistance to this "Fifth Column" are important in the highest degree. The present personnel of the Committee is of high standing, ranging from past and present Civil Engineers-in-Chief to the Admiralty to eminent consulting engineers and technical experts of harbour authorities. The reporter is Mr. J. Bryan. Whilst reinforced concrete is playing an increasing part in the design of wharves, etc., the superior elasticity, ease of repair and (generally) lower prime cost of timber have still much to recommend that material and this report will therefore be of general interest.

The Decline of Scottish Fishing Harbours.

Despite what has hitherto been done by means of Government grants to maintain or improve the fishing harbours of Scotland, many of the smaller ports are rapidly becoming derelict or unusable.

The trouble is not confined to one or two ports only, but is common everywhere on the Scottish coast. The lack of facilities is obviously a great deterrent to expansion of the fishing industry in such areas, and those responsible for the maintenance of local harbours have had their worries increased during the last few years as a result of the damage done by winter storms to piers and quays, and the impossibility of effecting repairs during the recent war.

Many of these villages, especially along the East and North-East coast, are so situated and laid out that their piers and breakwaters form essential and indispensable defences for the houses and property against encroachment and assault by the sea. Now, owing to the deterioration of their harbour works, a number of them are in danger of suffering further devastation by the waves.

In our view, there are many reasons why these little harbours should be preserved and maintained, as must appear clearly if a complete survey of these places were made and their condition and need definitely ascertained. No doubt, there are many cogent reasons at present—the prevailing national economic emergency, among them—why a scheme of small-harbour protection cannot be undertaken by the Government, probably for some time to come, but the need for definite action should be kept in mind.

Uniform Buoyage System for Trinity House.

A recent report in "Lloyds List" states that good progress is being made in the work of changing the system of buoyage under the jurisdiction of The Corporation of Trinity House as the result of the adoption by the corporation of a uniform system of buoyage. The task of repainting buoys and making light character adjustments where necessary will, it is hoped, be finished by the end of the summer. The percentage of work completed varies with each of the six divisions. For example, over 30 out of the 47 or so buoys in the East Cowes division have been adjusted, while a little over one-sixth of the work contemplated in the Harwich division has been carried out.

It will be recalled that the international agreement and rules for a uniform system of maritime buoyage was drawn up by a Committee of Experts set up by the League of Nations and signed at Geneva on May 13, 1936. Since the end of the recent war, the system has been embarked upon by several countries, and at the present time it is being brought into effect by stages around the coasts of France, Algeria, and the East coasts of Ireland and Scotland. It is understood that the British Government has not yet ratified the agreement.

Aerial View of the town of Toronto showing a part of the Central Harbour district.

The Port of Toronto

The Development of a Major Port on the Lakes of Canada

By E. L. COUSINS, C.B.E., C.E.
(Consultant to the Toronto Harbour Commissioners)

THE Port and Harbour of Toronto, through continued expansion and planned development, has gained an enviable position among the leaders of both Canadian Lake and Seaports. An inland port, 1,300 miles from the sea, Toronto has risen to become the third port of the Dominion. By reason of its strategic location as a focal point and natural gateway for the trade and commerce of the largest and wealthiest single market in Canada, the Port of Toronto is enabled to offer unexampled economic and commercial advantages to industry, manufacturers and all who use its harbour.

Toronto's modern $40,000,000 harbour is administered by The Toronto Harbour Commissioners, an appointive body serving without remuneration and incorporated under Federal Act of Parliament in 1911. Prior to the passing of this legislation and development of the harbour by the Commission, Toronto's waterfront facilities were totally inadequate and of little practical use.

Working to a comprehensive, planned development, the present method of administration has accomplished complete transformation. Development plans, on which actual construction started in 1914, provided for every phase of waterfront improvement. From shallow waters, marshlands and swamp, successive Commissions have forged a completely new and up-to-date port.

As recently as 1910, the Port of Toronto was in danger of losing even the small amount of water-borne trade it possessed. Inadequacy of vessel accommodation with consequent loss of tonnage discouraged both shipper and industry. There existed a preponderance of non-revenue producing lands covered by water, and in addition, numerous railway tracks running on street level presented a formidable barrier to the harbour's land approaches.

To-day, through negotiations, transfers and agreements, The Toronto Harbour Commissioners with the City of Toronto own and control 99 per cent. of the City's 10 miles of waterfront. Some 9 miles of concrete dockage has replaced the old wooden piers and wharves; unexcelled industrial sites, with ample rail and highway facilities have been reclaimed from former swamplands; and the largest vessels that sail the Great Lakes find ample efficient accommodation.

The harbour development plans provided for the construction of sea walls, permanent concrete wharves and piers, roads, dredging, and reclamation of low-lying areas. Some 8,000 soundings together with 200 borings were taken to ascertain the nature and amount of material, down to rock, available for reclamation purposes.

The plans included the removal of 35,000,000 cub. yds. of material by hydraulic dredging, all of which was used for the reclamation and improvement of industrial, commercial and park areas.

A new harbour headline across the entire front of the Inner harbour was envisaged and is now in the final stages of completion. (This development was outlined in the supplement to *The Dock and Harbour Authority* for December, 1921). The area reclaimed by this project provided the Central Harbour Terminals with more than 300 acres of manufacturing sites. The new harbour head wall was constructed a maximum distance of 1,100-ft. south of the old headline in order to save expensive rock excavation.

The reclaimed marsh at Ashbridges Bay, now the Eastern Harbour Terminals, provided more than 600 acres of industrial lands. A Ship Channel, 6,800-ft. long, 400-ft. wide and 26-ft. deep was constructed into the heart of this area. The channel terminates in a turning basin 1,100-ft. sq. and provides 17,000-ft. of dockage. The harbour itself has been dredged to a general depth of 24-ft. with provision made in all construction for an ultimate depth of 30-ft.

Structural changes have been made in the type of harbour head and dock walls used in the port development. These changes were determined to some extent by the introduction of deep arch steel sheet piling since the start of construction work in 1914; they were also determined, however, by conditions found in the harbour itself.

Port of Toronto—continued

At the Western Channel the depth to rock was 28-ft. below zero of the Harbour Commissioners' gauge. From there easterly to Cherry Street along the inner water front the distance to rock increases from 28-ft. to 40-ft. From Section II (see map) to the Eastern Channel, it increases again from 45-ft. to 70-ft. These greater depths precluded the use of standard cribwork as a sub-structure for walls.

The type of walls adopted depended largely on the depth of rock below mean water level. This was due to the fact that development plans provided for an ultimate navigable depth of 30-ft. When the depth to rock was approximately 30-ft. a crib type of wall was built; when the depth to rock was 40-ft. or over, a sheet piling wall was built.

The standard crib type of wall was used at the outset of the scheme, in connection with the construction of the harbour head walls from Bathurst Street easterly to Yonge Street. (A cross-section of this type of wall is shown on this page). These structures consisted of rock-filled crib work in sections of standard lengths of 100-ft. Berths or trenches were dredged to bed rock. By scribing the cribs and levelling the rock surface, an even bearing was provided for the cribs throughout their entire length and breadth.

After being sunk, the cribs were filled with stone. The various sections of crib were fastened together by inter-locking end posts. After the cribs were sunk in position, lined, filled with stone and allowed a reasonable time for settlement, the vertical posts were cut off and capped and the flooring laid to receive the pre-moulded concrete blocks. The elevation at the top of the wooden structure is 243. The super-structure consisted of pre-moulded concrete blocks, 8-ft. x 5-ft. x 5-ft. with sides bevelled front to back.

This type of wall was also used in the construction of the Exhibition sea wall and the Western breakwater (shown on this page).

Earlier construction on the Ship Channel walls was of tongue and grooved close sheet piling of British Columbia fir, made up of 12-in. x 12-in. timbers with strips spiked to both sides to form close sheet piling. They were cut off at the level of the top of the sub-structure at elevation 243.0, or 2-ft. below the zero of the Harbour Commission gauge.

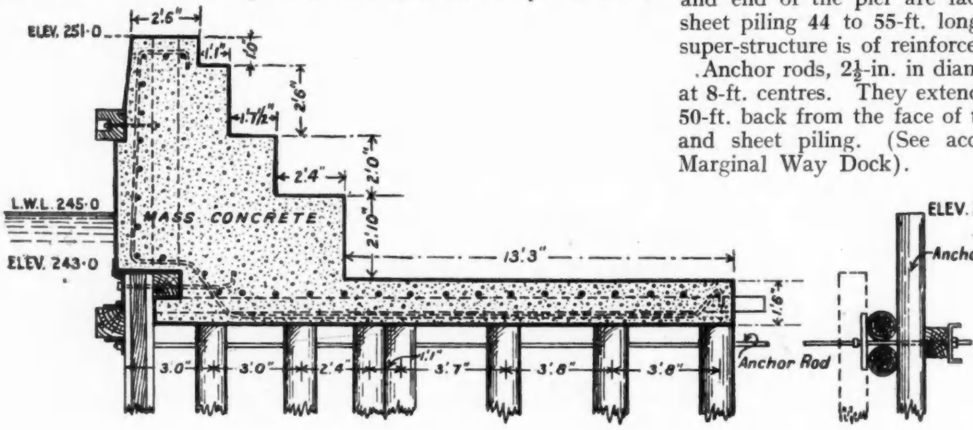
Pile bents driven at right angles to the line of the work formed the foundation for the wall and braced the wooden sheet piling. These piles were of spruce, 14-in. in diameter at the butt end and 8-in. at the point. Cap timbers were of 6-in. x 12-in. hemlock. This type of structure and its location in the harbour development may be noted in the accompanying cross-section and map.

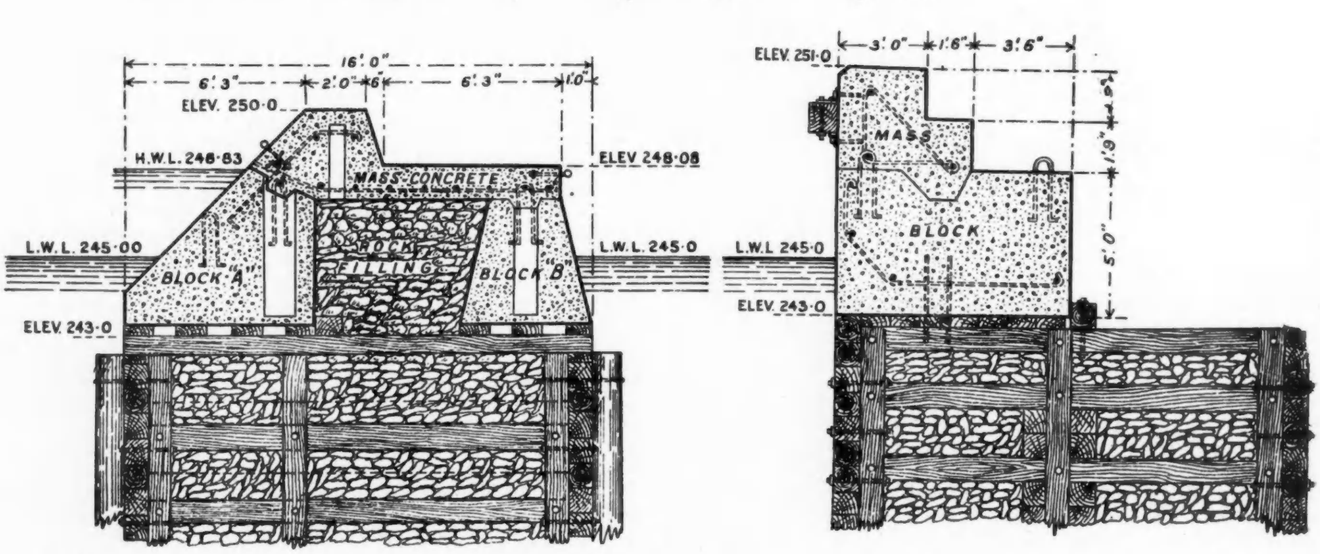
Of more recent date is the construction of the Marginal Way Dock (see accompanying map and cross-section) which was built in 1936 at a cost of some $900,000; Section 10 (see accompanying map) also built in 1936; and Section II (see accompanying map and typical cross-section) built in 1939.

The Marginal Way Dock extends 1,264-ft. into the harbour from the Marginal Way. The dock has a width of 778-ft. and a slip on either side, each 200-ft. wide. The area confined by the dock walls required some 1,500,000 cub. yds. of fill. This material was hydraulically dredged from dredging berths in Lake Ontario

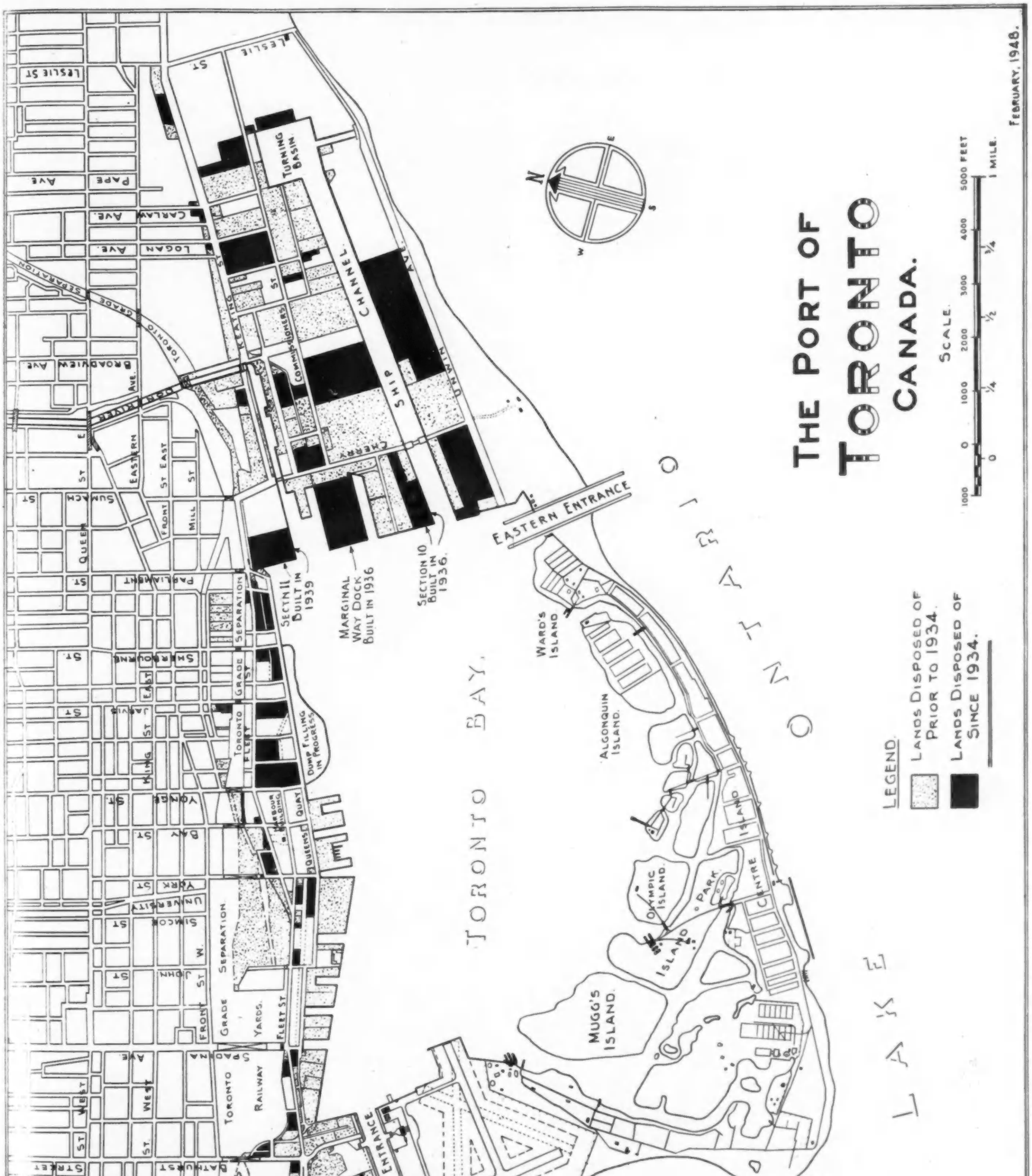
The dock walls are of the platform type, founded on round wooden piles spaced at 5-ft. centres and driven to rock. The sides and end of the pier are faced with deep arch sections of steel sheet piling 44 to 55-ft. long and 31.74 pounds per sq. ft. The super-structure is of reinforced concrete.

Anchor rods, 2½-in. in diameter support the wall and are spaced at 8-ft. centres. They extend from two anchor piles driven about 50-ft. back from the face of the wall, to and through the concrete and sheet piling. (See accompanying typical cross-section of Marginal Way Dock).

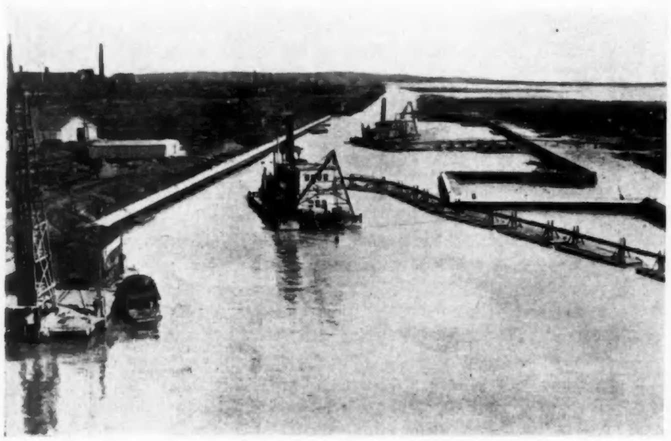




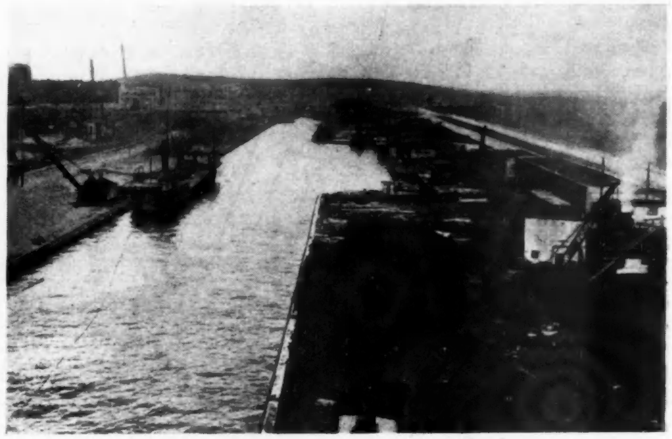
(Top) Section of Ship Channel Wall. (Bottom Left) Section of Western Breakwater. (Bottom Right) Section of Wall between Bathurst and Yonge Streets.


THE PORT OF
TORONTO
CANADA.
SCALE.
1000 0 1000 2000 3000 4000 5000 FEET
0 1/4 1/2 3/4 1 MILE.
FEBRUARY, 1948.
LEGEND.
LANDS DISPOSED OF PRIOR TO 1934.
LANDS DISPOSED OF SINCE 1934.
LAKE ONTARIO
TORONTO BAY
EASTERN ENTRANCE
WESTERN ENTRANCE
SHIP CHANNEL
TURNING BASIN
SECTN 11 BUILT IN 1939
MARGINAL WAY DOCK BUILT IN 1936
SECTION 10 BUILT IN 1936
DUMP FILLING IN PROGRESS
AIRPORT. CONSTRUCTED IN 1937-8.
WARD'S ISLAND
ALGONQUIN ISLAND.
OLYMPIC ISLAND.
MUGG'S ISLAND.
CENTRE ISLAND PARK
GIBRALTAR POINT.
LAKESHORE PARK.
OLD FORT.
TORONTO RAILWAY GRADE SEPARATION YARDS.
TORONTO GRADE SEPARATION
TORONTO FERRY
HARBOUR BUILDING
QUEENS QUAY
FLEET ST.
LESLIE ST
PAPE AVE
CARLAW AVE.
LOGAN AVE.
BROADVIEW AVE
SUMACH ST
PARLIAMENT ST.
SHERBOURNE ST.
JARVIS ST
YONGE ST
BAY ST.
YORK ST
UNIVERSITY
SIMCOE ST
JOHN ST
SPADINA AVE.
BATHURST STREET
STRACHAN AVE.
QUEEN ST
KING ST
FRONT ST
MILL ST
CHERRY ST
COMMISSIONERS ST
KEATING ST
UNWIN AVE.

Port of Toronto—continued



Keating's Channel, 1915.



Keating's Channel, 1920.

Aerial View of Central Harbour Terminals showing Toronto Island Airport in background.

Port of Toronto—continued

The harbour facilities at Toronto have been designed to give service to ocean carriers which will pass through a completed, modernised Great Lakes-St. Lawrence waterway. Passenger vessels, modern express package freighters and bulk cargo carriers of all types provide regular sailings to Great Lakes ports and direct connections by water with all ocean services on the St. Lawrence route.

A special feature of the harbour's controlled progress is the provision made in the original plans for parks, recreation and scenic beauty. Toronto was the first city on the North American continent whose harbour development included the esthetic from the very outset. This, of course, in conjunction with provision for industrial and commercial development.

To manufacturers and industry in general, Toronto Harbour now offers approximately 50,000 lineal feet of berthing space; perfect co-ordination of all traffic by water, air, rail or highway; 32 miles of Toronto Harbour Commission railway trackage; three grain elevators with a 7,500,000 bushel total capacity; cold storage of 2,500,000 cub. ft. capacity; a dry storage area of 750,000 sq. ft. and substantial transit shed floor area.

To-day, after 35 years of continued development, the port affords the utmost in co-ordination of transit facilities. Canada's two trans-continental railways connect with Harbour Terminal trackage owned or controlled by the Commission. The harbour's industrial areas are most accessible to the railways. The finest highway system in Canada ensures transportation of freight direct from the docks to any part of the surrounding country with ease and speed.

Toronto is a major distributing point, with a consequent saving in freight costs. Some 2,000 public carrier trucks operate from Toronto to various outside points with inter-provincial and international connections. Well over 200 freight and passenger trains arrive and depart from the city daily. Ships from European, Canadian and U.S. ports now make Toronto a port of call.

The cargo tonnage of the port has grown from little more than a quarter-of-a-million tons prior to the development, to 4,107,848 tons in 1947. Many important factors have contributed to this spectacular advance; an advance which has seen the Port of Toronto reach the status of a major port and an important factor in the commercial and economic development of the Dominion.

The natural advantages of location have, of course, contributed to the port's growth. The ability to command and utilise as many avenues of transportation as possible from a single point is one of the things most eagerly sought by manufacturers and distributors. The harbour's modern transportation services, combined with its sound and well-built docks; ample berthing spaces; accessible real estate and adequate depth of water, afford industry, manufacturer and shipper savings in both time and cost.

An additional port facility is the Island Airport, a combined airport and seaplane base in Toronto Harbour. (See accompanying map). Built in 1937-38, it is the only airport on the North American continent within a mile of a city's principal railroad terminal and the leading hotels. Aircraft arrivals and departures at the airport totalled 15,355 during 1947.

Two of the principal items comprising the water-borne trade of the harbour are coal and petroleum products. During 1947, the largest single cargo to arrive in port in one sailing was one of 11,[illegible]61 tons of coal. Another large single shipment was the receipt by tanker of 1,500,000 Imperial gallons of gasoline.

Coal handled at Toronto Harbour during 1947 totalled 1,[illegible]1,018 tons. This tonnage was brought from England, Scotland, Wales, Nova Scotia, the United States and the Upper Lakes. The port now handles 50 per cent. of all coal and coke shipments coming into the City of Toronto, second City of Canada.

In 1936, only six oil companies occupied water-front lands. In 1947 this figure had risen to 11, with a total storage capacity of 146,000,000 Imperial gallons. During 1926 the port handled only 29,000,000 Imperial gallons of petroleum products. This had increased to 212,000,000 Imperial gallons in 1937, and 364,000,000 Imperial gallons in 1947.

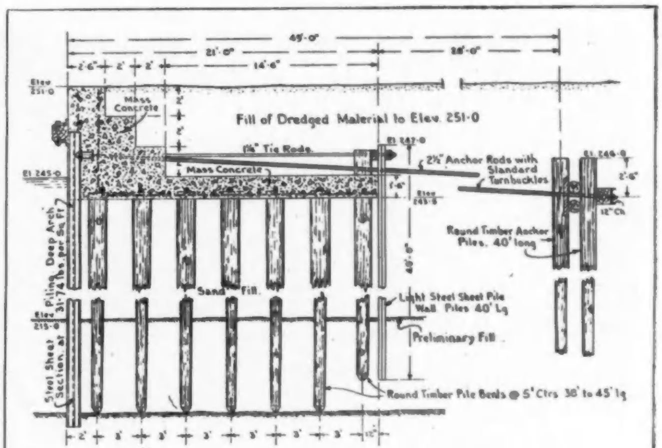
Grain shipments handled at the port during 1947 totalled close to [illegible]9,000,000 bushels.

The year 1947 witnessed an all-time record for the influx of new business and new plants in the Toronto Port area. Business concerns bought or leased last year some 96 acres of water-front and inland port properties. The total value of all harbour real estate transactions for 1947 was $3,500,000. To-day the assessed value of occupied harbour lands is just over $30,000,000; in 1912, prior to the development, the assessed value totalled less than $2,000,000.

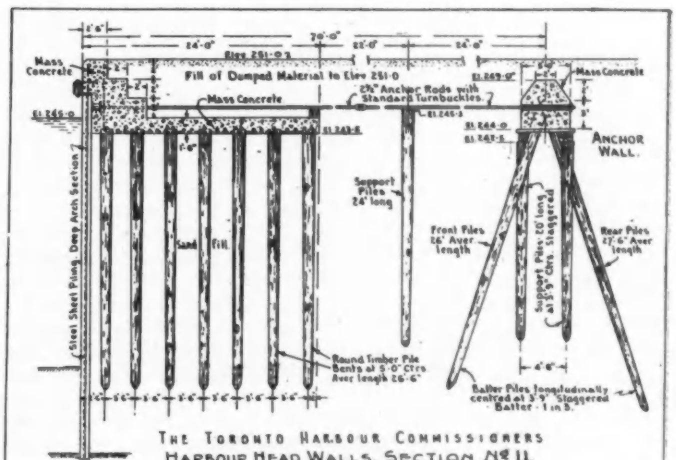
Industrial development is a very important part of the port's activities. The Toronto Harbour Commissioners have title to some 2,750 acres of land, of which 2,200 acres were covered by water at the start of the development scheme. Since that time more than half of the land previously under water has been reclaimed. Close upon 600 acres of manufacturing and industrial sites are now occupied by business enterprises in the harbour's two industrial areas; the Eastern Harbour Terminals and the Central Harbour Terminals.

The Eastern Harbour Terminals is a water-front area created expressly for heavy industry. It covers more than 1,300 acres and is serviced by the Ship Channel, Turning Basin and Keating's Channel. Located here are oil refineries, oil tank storage firms, coal yards and other industries.

The Central Harbour Terminals covers more than 400 acres and is especially designed for light manufacturing and warehousing. Various commercial enterprises are carried on in this region.



THE TORONTO HARBOUR COMMISSIONERS
MARGINAL WAY DOCK.
TYPICAL CROSS SECTION.
SCALE FEET



THE TORONTO HARBOUR COMMISSIONERS
HARBOUR HEAD WALLS. SECTION Nº 11.
TYPICAL CROSS SECTION.
SCALE FEET.

Port of Toronto—continued

Aerial View of Sunnyside Beach known as Toronto's Lakeshore Playground. Prior to development, this area was generally under eight to ten feet of water.

Toronto Harbour's Eastern and Central Terminals, by reason of their position in the overall transportational structure and the modern facilities which they command, provide the utmost in commercial and economic advantages. Both areas are served by all the necessities and conveniences attendant on modern industry, including sewers, water mains, paved side walks and roads, railways, hydro-electric power, modern docks, and gas.

A feature of the terminals and of the entire inner harbour is that their industrial sites and docks are from one to three miles distant from the business heart of the City of Toronto. Toronto is the capital of the Province of Ontario with a population in excess of 1,000,000, including the metropolitan area.

One of the greatest assets to the City, and a feature enjoyed by occupants of harbour lands and dock users particularly, is the great traffic escape-route known as the water-front highway. This thoroughfare, with a minimum pavement width of 50-ft., parallels the City's water-front for a distance of some 7 miles.

Generally, the western section of Toronto's water-front has been developed by The Toronto Harbour Commissioners as a recreation and parks area. Along this western water-front and paralleling the shore line, is the playground area known as Sunnyside Beach—Toronto's Lakeshore Playground. This area, generally, prior to the development was under 8 to 10-ft. of water. Sunnyside to-day provides opportunity for swimming, dancing, canoeing, etc. A modern, outdoor swimming pool, one of the largest on the Continent, is operated in conjunction with the Sunnyside Bathing Pavilion.

Following the shore line and passing through the western development is the wide, paved Boulevard Drive, flanked for more than 2 miles by a 24-ft. wide broad walk. Some 350-ft. from shore and paralleling Sunnyside's beaches and shore line parks for a distance of close to 4 miles, is a concrete breakwater providing a sheltered waterway for canoes and other small craft.

Physically, the Port and Harbour of Toronto is an area covering the entire 10-mile length of the City's water-front. The Inner Harbour is land-locked and covers an area of some 2 sq. miles. It is the only harbour of refuge on the north shore of Lake Ontario.

The port is just 26 miles from Port Weller, entrance to the Welland Ship Canal which links Lake Ontario with Lake Erie and the Upper Lakes. Eastward are the St. Lawrence River Canals, connecting link with ocean shipping.

Toronto and its port welcome British industry. In past years a representative of The Toronto Harbour Commission visited the United Kingdom for the express purpose of making available all information regarding Toronto Harbour.

The Toronto Harbour Commissioners have desirable lands avail-

Port of Toronto—*continued*

able in both Harbour Terminal districts. These industrial and commercial sites, providing concentration without congestion, are available through long-term lease arrangement and in many cases may be purchased outright.

Tangible evidence of the port's growth is readily seen from a study of the following tables:—

Waterborne Traffic of Toronto Harbour.

Year	No. of Vessels	Cargo Tons (In tons of 2,000 lbs.)
1928	1,921	744,819
1931	2,507	2,122,066
1935	5,607	3,020,130
1946	3,824	3,383,252
1947	4,920	4,107,949

Inbound and Outward Passengers carried by Steamship at Toronto Harbour.

Year	No. of Passengers Inward	No. of Passengers Outward
1940	193,766	198,528
1946	270,140	276,792
1947	278,598	296,000

Table of Coal Shipments Handled (In tons of 2,000 lbs.).

Year	Tons
1930	225,992
1935	1,565,264
1946	1,405,124
1947	1,721,018

Growth of Waterborne Oil Trade (In tons of 2,000 lbs.).

Year	Tons
1944	1,199,136
1945	1,134,478
1946	1,143,738
1947	1,456,282

The Port of Cardiff

Announcement of Lock Repairs at Bute Docks

The Railway Executive (Western Region) recently gave notice that the Queen Alexandra Dock Lock, Bute Docks, Cardiff, will be closed for approximately seven months after the p.m. tide of November 7th, 1948, for the purpose of repairs and alterations to the lock. Due notice of the date of reopening will be given. During the period the Queen Alexandra Lock is out of use vessels will enter and leave via the Roath Lock, the cill depth of which is 4-ft. less than that of the Queen Alexandra Dock Lock.

The Queen Alexandra Dock Lock is the principal lock entrance in use at the Port of Cardiff, and its closure must inevitably mean some interference with the normal trade of the port, but the gates at present in use are those originally provided when the lock was constructed 37 years ago, and it is now 11 years since it was last necessary to put this lock out of use for any appreciable period. The present renewals have become imperatively necessary.

Fortunately, Cardiff has a second entrance to the principal dock system by means of which vessels of suitable size can enter or leave the Queen Alexandra Dock through the Roath Dock Lock and Basin. The Roath Dock Lock is 600-ft. long by 8-ft. wide, but as the depth of water on the outer cill is 4-ft. less than that of the Queen Alexandra Dock Lock, the enforced closure of the latter must necessarily affect that very valuable part of the normal trade of the port which is carried in the larger type of general cargo liner. The average depth of water on the outer cill of the Roath Dock Lock is 35¼-ft. on high water of spring tides, and 25¾-ft. on high water of neap tides.

The Dock Authority are well aware of the need for their doing everything possible to minimise the effects of this closure, and appeal to shipowners to assist them by giving the Authority the opportunity to consider any vessel which may appear to be a "borderline" case before making other arrangements. In this connection, it is pointed out that, first, a great deal could be done to lessen the effects upon the trade of the port during this somewhat difficult period if suitably-sized vessels could be substituted for the larger type of general cargo liners, and for vessels in position to reach the port on spring ranges to be allocated in preference to those which would arrive on neap tides. Secondly, attention is drawn to the fact that the closure at Cardiff will in no way affect the other South Wales ports, and that, therefore, should there be any cases where the larger class of ship has been fixed for Cardiff discharge or loading during this period, and reallocation cannot be made, such ships could readily be dealt with at one of the other South Wales ports, where equally efficient facilities are available.

Notable Port Personalities

LVIII—Mr. Leslie E. Ford

Mr. Leslie E. Ford, O.B.E., M.Inst.T., at present Chief Docks Manager (South Wales Docks), Docks and Inland Waterways Executive, who, as was announced in last month's issue of this Journal, has been appointed General Manager of the Port of London Authority from November 1st next, joined the Cardiff Divisional Superintendent's Office of the Great Western Railway in 1912. From 1914 to 1919 he served first with the Welch Regiment, then with the 2nd Battalion, Monmouthshire Regiment, to which he was commissioned in 1915.

Mr. LESLIE E. FORD.

Mr. Ford returned to the G.W.R., and held various posts from 1919 to 1921 in the Traffic Department, London Division, in the offices of the Superintendent of the Line and the District Goods Manager, Birmingham, and at stations in that district. He was included in the first quota of "special trainees" selected in the latter year. In 1923 he was appointed Personal Clerk to Sir Felix Pole (then General Manager); in December of the same year he was transferred to the Docks Department and attached to the Chief Docks Manager's Office in charge of the New Works Section. In 1926 Mr. Ford was promoted to be Outdoor Cargo Assistant to the Docks Manager, Cardiff, and in 1928 Assistant-in-Charge, Penarth Docks. He went to Swansea as Assistant Docks Manager in 1929 and was promoted Dock Manager, Port Talbot, in 1933. In 1938 he was appointed Dock Manager, Cardiff and Penarth Docks, which position he held for a year before returning to the Chief Docks Manager's Office as Principal Assistant (subsequently restyled Assistant Chief Docks Manager). He was appointed Chief Docks Manager on January 1st, 1945.

Mr. Ford is a Brunel Medallist (University of London). He was made an O.B.E. in the King's Birthday Honours List, 1945.

Reviews

Deterioration of Structures of Timber, Metal and Concrete exposed to the Action of Sea-Water. Nineteenth Report of the Committee of the Institution of Civil Engineers. Summary on Timber, by J. Bryan. Published by the Institution, 1947. 49 p.p., 10 illustrations and 6 tables. 5s. 0d.

It is a little unfortunate that the words "metal and concrete" appear in the main title of this valuable brochure, since in fact it is, as the sub-title states, purely a report on timber. The first Report of this Committee (constituted in 1916) was published in 1920 and also deals with timber. The experience of the subsequent quarter of a century is digested in this present publication.

The essential conclusion (p. 38) is that

> "Any species of timber efficiently impregnated with creosote is practically immune to marine borer attack in home waters. In tropical waters it is highly resistant to attack and will have a life of many years."

This is not a very novel view but is of great interest as showing that no real advance has been made in this important subject. The necessity of deep impregnation, aided in some cases by actual incision, is fully confirmed. Surface application has practically no value. Some success with other poisons has been obtained but creosote is, broadly speaking, satisfactory.

There are some interesting notes as to the behaviour of different species of marine borers.

Although it is mentioned that heavy charges of suspended alluvium prevent marine borers, there is no indication that this subject has been sufficiently explored. There was a case some years ago at the mouth of the Hai Ho, near Tientsin, where timber cribwork for a training wall was ruined by borers and yet the water is heavily charged with silt. In Shanghai marine borers are unknown. Is it clear whether alluvium produces any effect which may not equally well be ascribed to low salinity?

The list of timbers which are relatively immune to borer action, mostly of local origin, is given, with greenheart well to the fore. The advantages of using round piles are emphasized, especially from the point of view of more effective impregnation by creosote.

All harbour engineers would be well advised to obtain this report, which contains in a handy form almost all the essential facts concerning the resistance of timber to sea-water action. The shortage of timber at the present time has favoured the use of reinforced concrete and there is little prospect of change in this respect, but the extraordinary convenience of timber for certain classes of harbour work, together with its resilience, will always encourage its partial use. Unfortunately to get the best results it should not be cut or drilled after impregnation with creosote, so that the designer should go into great detail to ensure this.

HERBERT CHATLEY.

"Reinforced Concrete Designer's Handbook," by Chas. E. Reynolds, B.Sc., A.M.Inst.C.E. Fourth edition; 1948. (London: Concrete Publications, Ltd. Price 15s.).

This well-known work of everyday use in the design of reinforced concrete structures has been thoroughly revised and much new matter has been included. It comprises 360 pages, with 69 design tables and many fully-worked examples. The recommended methods of design and the short-cuts are those which have proved satisfactory in practice. A feature of the tables is that they can be used with most of the recognised codes of practice and regulations, including, to a large extent, the new (1948) British Standard code of practice for reinforced concrete buildings.

The new matter includes: The loads specified for buildings in British Standard Code CP4, Chapter V, and loads on wharves, sea walls, transmission-line poles, lamp posts, and sleepers. Extensions of the consideration of the effect of wind forces. Concentrated loads symmetrically or unsymmetrically disposed on slabs spanning in two directions. Table for uniformly-distributed loads on slabs spanning in two directions and continuous over one or more edges, based on the United States Joint Committee Report (1940), and in most respects similar to that given in B.S. Code CP 114. Formulæ for articulated girder bridges and for the analysis of hinged and fixed arches of any shape. Details of joints, hinges, and bearings. Principals of various types of thin vaulted roofs. Analysis of beams of irregular cross-section. Basis formulæ for the deflection of reinforced concrete beams. Basis formulæ for prestressed concrete beams. Revised tables for the design of beams and slabs. Data on the properties of sections. Complete specification for typical reinforced concrete construction.

In the compact form of the book it is impracticable to give the many complev formulæ for the numerous cases met with in the design of jetties, sheet-pile walls, vaults and domes, chimneys, and some types of arches, but sufficient is given to enable preliminary designs, which may only require checking in detail by the more elaborate analyses, to be prepared.

A Neapolitan Harbour Scheme

At the North Western tip of Naples Bay, near the Castel dell' Ovo, there is one of the oldest of the Neapolitan harbours, now abandoned. It is one of the historical relics of a busy commercial past guarded by a fortress at its most seaward point. It has served its purpose and now has not the necessary requirements of modern traffic. As a Neapolitan naively remarks " it is a little spot used by Nautical clubs and very low-class restaurants. In time past it was known as S. Lucia Harbour and is formed by a steeply-curved breakwater with its root in Castel dell' Ovo and its head doubled back into the bay almost in a direct line with the well-known "via Partenope"; the breakwater is almost 400 yards long and sweeps through an angle of over 90 degrees, enclosing about 16 acres of water space. The derelict condition of this harbour has inspired Italian engineers, foremost among whom is Mr. Giovanni Viggiani, to project a scheme of rehabilitating the old port into a maritime playground terminus. It is to be called "Nuovo Porto de Santa Lucia." There are ambitious proposals for the filling in of about 6 acres of the water space, and to erect thereon impressive buildings modelled on the sky-scraper style. These constructions are to accommodate centres of Art, Science, Culture and Pleasure.

The scheme has been approved by the local authorities and one of the ingenious pleas put forward by the promoters is that it will provide work for the present and probable unemployed in the Naples environs. However, in these troublous times, it is refreshing to know that old disused harbours can be utilised, in more fortunate climates, for the uplifting and disportation of those lucky people with a surplus, even if temporary, of leisure, and the good sense to indulge it in such harmonious surroundings.

R. R. M.

Relief Pilot Ship for Belfast

The Belfast Harbour Commissioners have taken delivery of their new relief pilot vessel and tender, formerly the steam yacht *Coila*. She has been named *Sir Thomas Dixon* after the senior member of the board. The vessel replaces the *Duchess of Abercorn* which has been disposed of as unsuitable for this service. At a commissioning ceremony on board, the chairman, Mr. John McCaughey, accepted from Sir Thomas Dixon a clock for the ship's saloon.

Dock and Canal Transfers.

The British Transport Commission announces that responsibility for the management and operation of the former railway-owned docks in South Wales was transferred on 1st August last, from the Railway Executive to the Docks and Inland Waterways Executive. The ports concerned are Newport, Cardiff, Penarth, Barry, Port Talbot, Briton Ferry, Llanelly, Burry Port and Swansea. The management and operation of the Shropshire Union Canal, Trent and Mersey Canal and the King's Lynn Docks and Railway Company, were transferred from the Railway Executive to the Docks and Inland Waterways Executive on July 25th.

The Heysham Jetty

By Professor ARTHUR LEMPRIÈRE LANCEY BAKER, B.Sc., M.I.C.E.

Discussion

The Chairman observed that the question whether the ship should damage the harbour works or the harbour works should damage the ship had always been a vexed one. It might be thought to have been decided with the advent of mass concrete walls, but he was not sure that was the correct attitude to take. It seemed to have remained for the more fragile jetty structure to show what was perhaps to be the way out. It was a very sore point with shipowners that their vessels should be damaged by harbour works.

Mr. A. C. Hartley congratulated the Author not only on an excellent Paper but also on his share in the provision of a safe berth under very difficult conditions and for giving the Mulberry pierheads an easier problem with which to deal. The Author had thanked the team who worked with him, but it was clear that he had played the leading part.

Mr. Hartley had been interested to see the principle of flexibility introduced into pierheads and jetties. He had always held the view that what could not be made absolutely rigid should be made flexible. That principle had been adopted on land for many structures, and it was very interesting to see it applied to marine work.

The provision of berths for tankers with the minimum of effort in men and materials was perhaps even more important to-day, than during the war. In war-time it had been possible to obtain materials, but that was very difficult at present; and if the fenders and dolphins which had been described made it possible to do the work with less material, and—even more important—in a shorter time, then, especially in view of the world shortage of oil facilities, they would represent a very great contribution.

Would the fenders enable a tanker to remain at a berth with, say, waves of from 4 feet to 6 feet in height and a wind of from force 4 to force 6? Further, would the Author consider that their object was to prevent damage to the jetty when tankers came alongside, and that off-moorings should be provided to hold the tankers away from the face of the jetty under difficult conditions; or should the tankers be held close to the jetty?

The Chairman had referred to the solid wall and the flexible ship. Many years ago, at Abadan, the dolphins had been made of screw piles. They looked rather flimsy, and some of the tanker skippers—very few— had thought that they could not damage their ships on them, and so did not take all the care which they might have done, so that the cost of repairs became considerable. Therefore it was decided to construct something which looked more substantial, and accordingly reinforced-concrete piles were driven, with a mass concrete top weighing about 200 tons and looking very formidable. All had gone well for many years, but recently a tanker had drifted away, and had exhibited the skill of a world champion heavy-weight boxer, because, without any real damage to itself, it had found out where to hit that 200-ton concrete mass "on the chin", shearing the heads off the piles, and tumbling the 200-ton mass of concrete into the mud behind, with very little damage. The Author had shown how shipowners and proprietors of quays could get together, not by using a great mass of concrete but by having something which would be flexible and would minimize any damage to the jetty and to the tanker.

Mr. H. D. Morgan expressed his congratulations upon the ingenious way in which the well-known principle of the moving fulcrum had been applied to dolphins. It was always difficult to design for large horizontal loads, because a pile usually had such a poor value in uplift. The Author had stated that the resistance to extraction was 15-20 tons immediately after driving. Was any measurement made after a period to ascertain whether those piles had improved in uplift? It seemed curious that piles having an estimated resistance to driving of 150-200 tons should have a value in immediate uplift of 15-20 tons—a ratio of 10 : 1. That seemed to imply that the whole resistance was point resistance.

Again, it was stated that some of the piles—he thought the majority—developed the resistance to driving through boulder clay of 150-200 tons in about 20 feet of penetration, but that occasionally a pile went as much as 70-90 feet. That was a very large difference. Had the Author any idea whether the majority of the piles with the short penetration came up against boulder, whilst the piles which went to a great depth were simply those which got by. That was rather suggested, and further information would be of interest.

Mr. E. L. Browning observed that the Author seemed to have assumed that the maximum blow due to a vessel berthing could be based on 40 per cent. of the kinetic energy of the vessel. In view of the accident mentioned in Appendix I, should not the maximum combined effect of both wind and tide be taken into account? Moreover, as bell dolphins came more and more into use, shipping would be prepared to take greater risks, and ships would use those dolphins under much more adverse conditions than would otherwise be the case. That might increase the availability of the berth, but the conditions of impact might be much more severe.

The ability of the bell to rotate was undoubtedly an excellent feature in the design, but Mr. Browning suggested that further investigation should be carried out on fendering materials to combine the absorption of the initial crushing stresses with the minimum of damage to the ships. Further, might not the bell itself be designed in a fully circular form, instead of the twelve-sided arrangement which had been adopted. That might help in reducing scraping and friction, whilst with the object of preventing undue rocking and swaying of the bell, it might be possible to extend the sides of the latter downward below low water of spring tides. Alternatively, perhaps some form of water spring or spring damper might be introduced into the design to help in that connection.

He concurred with Mr. Morgan's view that it seemed surprising that a penetration of 70-90 feet was necessary for 150-200 tons, whilst there was only 30 tons resistance to uplift. At Abadan piles had been driven through soft silted clay soil the shear strength of which had been determined at 350-400 lb. per square foot. That value had apparently been reached by those piles, which were 50-60 feet long, in frictional resistance to uplift. Had the Author considered using screw piles, or even screw cylinders for supporting the bells, They would undoubtedly have a greater resistance to uplift, and in addition they might have simplified the design in providing resistance of the structure to overturning.

Recently Mr. Browning had discussed the Heysham jetty with the Marine Department of the British Tanker Company, and had been given to understand that although at first they had been doubtful about the use of the bell dolphins, they were now so favourably inclined towards them that their adoption had been seriously considered for the development of terminals in other parts of the world. During the discussion with the Company one or two points had arisen which might be of interest. It was considered that there was insufficient height between high water of spring tides and the top outside edge of the bell, so that a light tanker would be inclined to sit on the top of the bell during times of swell: the view expressed was that the height from high water of spring tides to the top of the bell should not be less than 12-15 feet. The bell dolphins at Heysham were placed so as to take a large ship, whilst ships of smaller dimensions berthed against hanging fenders between the bell dolphins. It had been suggested that, to improve the efficiency of the bell dolphins, they should be spaced to take the parallel middle body of the smallest ship to used the berth. Another suggestion had been that it would be an improvement if each berth had three bell dolphins.

Mr. J. H. Jellett asked what was the normal movement of a ship berthed against the dolphins and fenders of the type described in the Paper, once the berthing operation had been completed and the ship was stationary. During numerous unloading operations such as getting a large-size cargo into a rather small hold, any kind of lateral movement of the ship might be very inconvenient. Although that question would not arise when the berth was used solely for tankers, and the necessary flexibility could be

* Paper (slightly abridged) read before the Maritime and Waterways Division of The Institution of Civil Engineers on 2nd December 1947 and reproduced by kind permission.

The Heysham Jetty—continued

imparted in the ship-to-shore oiling connexions, it might be an important factor in ordinary cargo-handling.

For such purposes the Author might care to consider the introduction of some form of locking device whereby the movement of both the dolphins and the fenders could be locked after berthing, leaving only the normal elasticity of the jetty structure to function in the ordinary way.

The use of the force of gravity to reduce impact in the manner described was a new departure, but Mr. Jellett regarded it as slightly disappointing that the values for the energy which could be absorbed in that manner had not increased in a rather more spectacular manner than was in fact the case. In 1928,[1] Mr. C. P. Taylor and Dr. Oscar Faber, MM.I.C.E., described a jetty constructed at Northfleet by the ordinary orthodox methods and provided with the usual type of fendering, designed to accommodate a 12,000-ton ship coming alongside with a linear velocity of 1 foot per second—which presumably meant that, in such circumstances, the 40-per cent. reduction factor which the Author had employed should not be applied. That question of velocities at impact was of some importance, and had recently been discussed in the technical press[2] following a suggestion that maritime engineers had hitherto been designing for unnecesessarily high velocities.

In 1928 the velocity designed for was 1 foot per second; in 1942—43 it was still about 1.25 foot per second, and a maintainance engineer still received about one request per week for repairs to the structure of some jetty which had suffered unduly from the impact of a berthing ship. Mr. Jellett suggested, therefore, that the velocity at which berthing could take place without damage to either ship or structure, might be increased considerably.

In the absence of comparative costs, under similar conditions, of the structures at Northfleet and at Heysham, it was difficult to say whether his comparison of the berthing speeds was quite fair, but he thought that the point was worth consideration.

The berthing operations at Mulberry had not come under Mr. Jellett's personal jurisdiction, but he could state that tugs were used for berthing at the L.S.T. ("Landing-Ships, Tanks") pier. That need not be taken as any reflection on the fenders, because the skippers of the various craft using the pier—L.S.T. and L.C.T.—belonged to a wide range of "types," and if they had been told that they could berth at 4 knots they would have given a very liberal interpretation to the meaning of 4 knots; therefore it was advisable to take them gently but firmly in hand with a couple of tugs and berth them at the official estimate of the correct speed. It might be of interest to mention, however, that the best time for unloading an L.S.T. from the moment of immediate approach, berthing, unloading both decks of tanks and motor transport, and getting away, was 45 minutes; and Mr. Jellett regarded that as quite a meritorious performance, for which the Baker fenders could claim their due share of the credit.

Mr. D. H. Little observed that the Author had made such generous acknowledgments to all who had helped him, that people who did not know him might wonder what he himself had really done. Mr. Little believed the position was that before the war started the Air Ministry decided to have all their oil fuel work done for them by three commercial firms, of which the Author's firm was one, and the Author had naturally had a fairly free hand. His staff had consisted of only three or four assistants, but he had frequently consulted with the Admiralty staff at Bath on other matters, and had accomplished an enormous amount of work, which had been made possible only by his calling upon various specialists to help him. The fact that he was able to work in that way was the only reason why the dolphins were ever built. They were such a novel conception that it was doubtful whether any private consultant would ever have put them forward or whether the permanent staff of any Government department would have been allowed to proceed with them; but the Air Ministry had given him the work and so long as he produced results they had not minded how he did it. The dolphins were an outstanding achievement and represented a milestone in maritime civil engineering.

The Author had stated that the ultimate resistance to downward load of the 18-in. by 18-in. piles, with 15-25 feet penetration was 150-200 tons. With that penetration the frictional area would be between 90 square feet and 150 square feet, resulting in a frictional resistance of between 3,700 lb. and 3,000lb. per square foot. Those values might be expected for the cohesive strength of a boulder clay, but Mr. Little agreed with other speakers that tensile loads might be expected to develope the full adhesive strength just as much as compressive loads, and he would have estimated that the tensile resistance would be exactly the same as the other resistance, namely, 150-200 tons.

The maximum value of 270 tons given for the static pull on the bollard seemed very high. For the largest warships the Admiralty always took 100 tons—though it was true that that was in sheltered water. At a certain East Coast port, a berthing master had once shown Mr. Little a 100-ton spring which had been inserted in the mooring ropes to bring ships in and had stated that occasionally that spring would be closed in rough weather; that again indicated 100 tons. The breaking strength of a wire rope 5½-in. in circumference was a little more than 100 tons; but Mr. Little doubted whether wire ropes as large as 5½-in. were ever used for mooring vessels, so that the 100-ton upper limit seemed to be a fair value for adoption. On what basis had the Author obtained the value of 270 tons?

It was interesting to find that considerable use had been made of steel box piles, and Mr. Little believed that they would continue to be used. The high-light of the jetty, however, was the bells, which had set many people thinking along the lines of flexible fendering. The Author had developed some and the Admiralty others. Mr. Little exhibited a model of a fender built by the Admiralty at Belfast, which presented the advantage that there was suspension from the cap, with no under-water bracing. Admiralty ships were berthed with catamarans, so that lateral resilience was obtained by the "chatter" between the catamaran and the ship, but without the catamarans the arrangement might not be so successful.

For lighter vessels the Admiralty were developing a fender pile with bonded rubber as the spring unit. The energy-capacity was only 50-70 inch-tons, but it was obtained in every direction. The rubber was in shear and it was possible to push and pull it at any angle and still have the same absorbing resistance.

Mr. J. E. G. Palmer observed that the problem of absorbing the energy of a moving ship was one with which his own firm had had to deal in the past, and they were struggling with it at present in several parts of the world. The Author had hit upon a novel method of absorbing energy. The value of 1,900 inch-tons for the bell dolphins was not, however, excessively high. Mr. Palmer's firm had designed an oil jetty in the Mediterranean about twelve years ago, and had adopted a type of fender rolling back on to springs. The energy absorbed by one of those fenders was about 1,728 inch-tons, and several were installed along the jetty. At a small oil berth on the East Coast of England the firm were applying what was perhaps a novel principle for absorbing energy, namely, the principle of stretch. The fenders there would probably absorb about 1,800 inch-tons, which was comparable with the Author's value.

The total cost of the Heysham jetty (£275,000), did not seem excessive for a jetty on a difficult construction site. Could the Author state how much a pair of the bells described would cost under present day conditions.

The other novel idea which the Author had introduced—the suspended type of fender—seemed of much more practical interest. Mr. Palmer had calculated that three of those fenders would absorb 50 per cent. more energy than would one of the bells, whilst their cost would probably be only about one-tenth of the cost of a bell. If accurate figures could be given, they would be of considerable interest.

[1] C. P. Taylor and O. Faber. "Deep-Water Jetty at Bevan's Cement Works, Northfleet." Min. Proc. Instn Civ. Engrs, vol. 226 (1927-28, Part 2), p 290.

[2] R. R. Minikin. "Impact Stresses in Jetties." *Dock and Harbour Authority*, vol. 28, No. 309 (July 1946), and Correspondence.

The Heysham Jetty—continued

Further, could the Author indicate frankly the disadvantages of the hanging vertical fenders? At the moment Mr. Palmer was engaged upon a scheme for a large six-berth tanker jetty which he hoped would be festooned thickly with the hanging cylinder type of fender, and he would like to know all the disadvantages. He had seen a drawing of the Heysham jetty which bore a note that the hanging fenders had to be hooked or locked back if any heavy waves were expected. That might not be a serious disadvantage if the hooking or locking could be simply done. Mr. Jellett had suggested that it would be advantageous if the fenders could be locked. Against what kinds of waves would the locking be necessary?

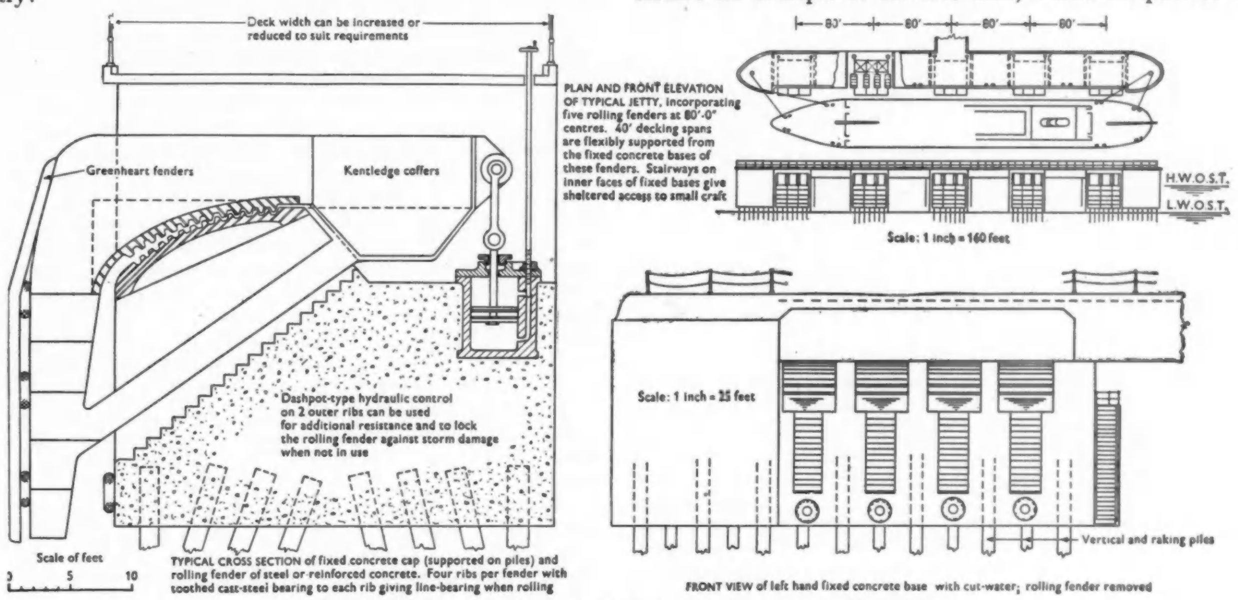


Fig 9. Suggested Application of Dolphin for Mooring of Ocean-Going Ships.

There could be no doubt that the site of the jetty was a difficult one: Mr. Palmer would have liked to see a map of the whole area. The piece of water known as the Heysham lake was a very deep channel running about 3 miles from the main part of Morecambe bay. The sand spit dried to about 15 feet at low water of spring tides and was flooded to about 20 feet at high water of spring tides, so that large waves would come in and go right over that spit at high water. It would be interesting to know, however, whether the waves ceased after three or four hours, or whether they came right in all around the clock. When Mr. Palmer had inspected the jetty it had appeared to be in first-class condition, despite six or seven years of heavy use during the war.

Mr. R. S. Jenkins observed that it might be useful to state briefly the principles underlying the structural design of the jetty. That design had really centred around the idea of absorbing kinetic energy by doing work against gravity, which was entirely the Author's own conception; and his original sketches were very like the bell dolphins as they were finally built after all the calculations had been made to determine the stresses.

Like all good inventions, its most striking feature was its simplicity. Reference had been made in the Paper to opposition to the scheme, and it was easy to see how that could happen. Very often scepticism seemed to be proportional to the ease with which a proposition could be proved.

So far as the remainder of the design was concerned, the basic theory was that of pile groups. The classic works on that subject were by A. Ostenfeld, in 1921, and C. Nokkentvedt, in 1924, both of which were in Danish; they had been translated into German, and other German literature on the subject had been published. Very little English literature was available. In 1934-35 articles in *Concrete and Constructional Engineering* had summarized those works for plane pile groups in which the piles could be considered as hinged top and bottom, but the main purpose of those articles had been to investigate energy-absorption and the best development of piles.

Pile-groups could be divided into two classes, in the first of which the stability was high, even when the piles were considered as hinged top and bottom. In that case the bending in the piles was very small in comparison with the direct forces, and could be negelcted. In the other class instability was approached if the assumption of hinging was made, and in that case the bending could not be neglected, but played a part in the pile stresses and and in the elastic properties of the whole group.

The pile groups of the dolphins and the centre of the T-head formed an example of the first class, whilst the piles in the approach jetty formed an example of the second class. In the elastic theory of pile groups when any force acting on a rigid cap connecting a group of piles was resolved into forces in couples at a convenient point of reference, the elastic movements at that point were related linearly to the applied forces and the pile forces were related linearly to the elastic displacements. In a pile-group there was usually one most suitable arrangement of piles, everything being considered, and also an ideal static load, taking into account the resistance of piles to buckling or further penetration and to uplift. At Heysham the uplift was very small in comparison with the further penetration. The static weight of the dolphin was of the order of 1,000 tons, so as to hold the whole thing down and give the best arrangement.

All of the elastic properties of the pile-groups and the connections of both the approach jetty and the main jetty had been taken into account in trying to get the most out of them within the general scope of the design, to provide horizontal lattice girders and decks which could utilize the maximum spread of which the construction was capable. That policy had been well justified when it was decided later to instal the cylindrical fenders between the dolphins, and that work had been carried out without it being necessary to strengthen the rest of the structure in any way.

No reference had been made in the discussion to the contractors: taking everything into consideration, they had had a very difficult piece of work to do, and they fully deserved the tribute which the Author had paid to them.

Mr. E. Johnson observed that the alternative design illustrated in Fig. 9 would provide four 36-foot wide vertical fendering faces at intervals along the ship's side, instead of two 12-foot wide faces, one at each end, thus giving better distribution along the ship's framing.

The cost per rolling fender should be lower than in a "bell" design, as there would be only four vertical ribs per fender, all

The Heysham Jetty—continued

"once circular" work, as against twelve per fender of "twice circular" or spherical work.

The toothed bearing gave positive "line" bearing instead of point loading.

Blows on ribs were taken back through an inclined strut directly to the position of counterweight; thus the ribs would not need to be designed as cantilevers; but that might result in forming a "harsher" shock-absorber. Hydraulic dashpot-type control could be easily contrived, to prevent the rolling fenders "fighting" with the ship alongside in violent weather and to lock the fenders against unnecessary movement when not in use.

Better arrangement of pile-groups was possible in a rectangular dolphin cap, which was dimensionally independent of the rolling fender, than in a circular dolphin cap limited in size by the dimensions of the circular cap which it supported.

Because the longitudinal distance between fendering units would not generally be more than 40 feet, they could act as supports for light prefabricated decking, and no piling would be required between the main units to support the deck.

The arrangement described above should facilitate the provision of means for boarding and disembarking, by means of stairways, gangways, or small craft.

The proposals were made with due reserve, as a basis for fuller consideration and not in any critical spirit, as Mr. Johnson's close connection with the Heysham jetty throughout its construction allowed him to appreciate the capacity of its originator as well as the merits of the original design.

The Author, in reply expressed his thanks for the kind remarks made by Mr. Hartley. With regard to the question of whether or not it was desirable to hold a tanker off dolphins, under certain conditions it was extremely difficult to say where to draw the line. At Heysham, under the most servere weather conditions in the early stages of using the berth, when the policy was to hold the tankers as tightly as possible to the dolphins, a vertical movement of the tankers of 12 feet took place, and a horizontal movement—ranging in and out, with the stretching and re-pulling of the mooring ropes—of about 15 feet. The Author had not been present on those occasions, so that he had had to rely upon reports from the site; but he had checked the accounts given by various people who had been there. Therefore he considered that under the severe conditions at Heysham, where the depth of the waves probably attained 6 feet or more, it was not possible to hold a tanker still. A movement of 12 feet up and down meant that a complete timber fender might be worn away in the course of 24 hours. For a site similar to that at Heysham, therefore, he would advise holding the tanker off and using the dolphins as a check in case the ropes broke or the anchors dragged. For the condition intermediate between the extreme case of Heysham and the fairly quiet harbour, it should be possible to restrain a tanker sufficiently by mooring ropes, so that the movement taking place would not cause serious damage provided that the tanker was riding against suspended fenders or some type of highly resilient fender.

The Berthing Master's report in Appendix 3 (see Footnote A), provided further information in regard to Mr. Hartley's question, and the Report on the Trial Borings in Appendix 4 (see Footnote B) indicated the presence of sand, which probably accounted for the low resistance of the piles to extraction.

Screw piles were not used on account of the special plant required, the high cost, and the uncertainty of their supporting power. The height of the dolphins was not made sufficiently great for the extreme case of an unballasted tanker berthed at an exceptionally high tide, as the design to withstand the high overturning moment involved would have become even more elaborate. For such exceptional circumstances it was considered that the tanker should take in ballast. The Northfleet, and other similar jetties, could only move horizontally, at the most a few inches, without excessive stresses occurring in the piles. To absorb 1,500-2,000 ton-inches of kinetic energy, therefore, entailed either overstressing the piles or applying a pressure on the ship of 500-1,000 tons, thereby probably buckling plates. The bell dolphins and suspended fenders, by their movement of from 40 to 50 inches, reduced the impact forces to one-tenth to one twentieth of those values. The locking chain referred to by Mr. Palmer was a provisional device to be used if found necessary. In the roughest weather the fenders only developed a slight quiver from wave action. Therefore, the chains had not been used. It was interesting to record that a horizontal type of fender, suspended in a similar way to those at Belfast, was first suggested at Heysham by Mr. Horne. The vertical-type fenders used were preferred on account of their small resistance to wave action, simple construction, and slight rotational and longitudinal freedom of movement.

Mr. Morgan and Mr. Little had commented upon the apparent discrepancy between the results of the tests for the supporting piles downwards and the resistance to extraction upwards of the test-pile. The cause was probably the presence of a certain quantity of silt in the clay through which the test-pile was driven and extracted. Over certain parts of the site a considerable depth of silt and fine sand occurred, and the test borings had indicated the presence of a certain quantity of silt below, so that the test-pile might not have been entirely in clay. Moreover, during the test a small trawler had been used on the rising tide to lift the pile, and a tension-gauge inserted in the line hoisting it upwards, and probably some movement had occurred, so that the pile was moved laterally, thus producing a certain degree of lubrication by water and thereby reducing the normal friction or cohesion resistance which was to be expected in clay. Possibly the explanation lay in a combination of those two factors. A much higher resistance to extraction had been expected in the first place, and it had been necessary to modify the design accordingly when the rather alarming test result was known. Considerable additional ballast had to be provided in the pile caps, so that the raking piles had the initial downward load from the ballast, because it was felt that no greater resistance to uplift than the test-pile had shown could be relied upon, though probably in most of the piles the resistance to uplift was much greater. It had not been possible to measure that, and the Author did not see at the moment how it could be done without serious risk to the jetty. Detailed reports on the driving and extension of test piles were given in Appendix 5 (see Footnote C).

The factor of 40 per cent. of the kinetic energy was employed only for lateral blows from a ship swinging so that the full weight of the vessel did not come behind the blow. For a head-on collision the full kinetic energy would be assumed. In the case of the head-on collision reported in Appendix I, the exact velocity of the vessel was not known;but probably it was about 1-ft. per second. The fact that the outer cage was pushed to its extremity supported that estimate, because there was an energy-absorption of 1,900-2,000 inch-tons.

Mr. Browning had suggested that an improvement might be effected by making the outer cage circular. That had been considered, but a polygonal horizontal section was adopted so that with a tanker tied in the berth the load would be spread over a horizontal length of 12-15 feet. In the event of a collision from a glancing blow on a corner. the bell should rotate and align itself with the side of the ship, thereby again avoiding line contact and avoiding concentrated pressure, possibly between the ship's frames.

In reply to Mr. Little, the value of 270 tons horizontal resistance for the bollard was rather misleading. Originally, the possible pull which might be obtained under some extraordinary condition on the bollard was estimated at 200 tons. The Author believed that some of the mooring lines were 6-in. ropes, and, judging from the experience in fairly quiet harbours to which Mr. Little had referred, it might be that on a site such as Heysham the pull might occasionally attain 150-175 tons, so that 200 tons was not excessive for that particular site. But the bollard also acted as a shear-pin in transmitting longitudinal blows to all the piles in the case of end-on collisions, and therefore it required the high strength given to it. When the work was started, moreover, it was necessary also to consider the possibility of a tanker colliding with the bells in a high gale, and then of the wind continuing to blow in a gust which might last only a short time, whilst after the kinetic energy had been absorbed the gust might still continue and apply pressure to the whole of the dolphin. For those reasons it was considered that provision for a horizontal resistance of 200 tons in

The Heysham Jetty—continued

any direction was not excessive. In carrying out the detailed design, however, it was found that a resistance of 270 tons had to be provided for the reactions from impact forces, in order to absorb the kinetic energy which had been specified.

It was very difficult to say what another bell dolphin might cost; that would depend upon the site and upon many other conditions. Possibly that type of structural steelwork could be erected for £100 per ton. At Heysham the tide rise attained 37-ft. under extreme conditions; normally it was 30 feet, and the bell was of exceptional size and diameter, the total weight of structural steel being about 120-130 tons. On other sites, with a smaller tide rise and less severe conditions, the weight of structural steel might be only 50 tons. The additional weight could be provided by ballast. At Heysham the ballast amounted to nearly 50 tons, but in other cases more ballast could be provided at low cost in order to obtain the weight. In future construction it should be possible to pre-cast in concrete the ribs of a similar type of bell, and to join them together with pre-stressing methods in a similar way to that used in the construction of bridges by Freyssinet in France.

Mr. Palmer had asserted that the shock-absorption provided was not really very high in comparison with that of some other jetties. Wherever spring buffers were used, unless a tremendous sum of money were expended on special hydraulic buffers, it was not usual to have the shock-absorption much greater that 200-300

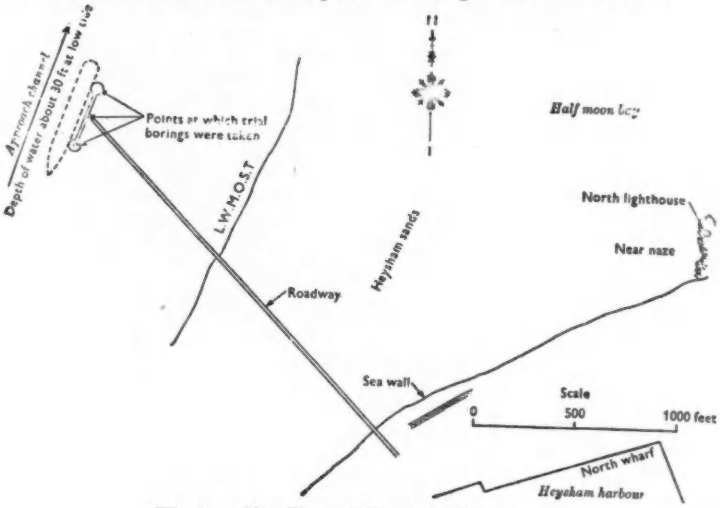


Fig 10. Site Plan of Heysham Jetty.

inch-tons. The shock-absorption of the bell could be increased by adjusting the curvature of the bearings to give greater movement and by using more ballast to provide more weight.

With suspending fenders, each fender could have a shock-absorption value of about 1,000 inch-tons, and that type of fender was very cheap. By providing a large number, it would be possible to obtain very high shock-absorption indeed. It depended entirely upon the variety of craft liable to use the berth whether the fenders should be concentrated in groups or spread out at regular intervals. It was imposible to generalize on that point. The site plan requested by Mr. Palmer would be found in Fig. 10.

With regard to Mr. Johnson's proposal, the arrangement lacked the rotational movement which had proved advantageous in the case of the bell dolphins. For fendering intermediate between end bell dolphins the suspended type of fender was probably the best, as it was simpler and had a certain amount of longitudinal and rotational freedom.

The Author was grateful for Mr. Jellett's answer to his question about the use of the fenders at Mulberry, and also for the excellent explanation by Mr. Jenkins of the way in which he had made the fairly difficult calculations for determining the distributions of the forces in the piles and the grouping of the piles so that, for all conditions of tide and load, and all combinations of horizontal and vertical loads, the minimum forces would be produced in the piles.

A. Extract from Appendix 3—Berthing Master's Report on Berthing of Tankers at Heysham Dolphins.

M.V. Laurent Meeus.

24.10.41. Berthed at Oil Jetty. This was the first vessel to berth alongside, and results were extremely satisfactory. Wind W.N.W. force 6, sea and swell slight.

M.V. Ferncastle.

30.10.41. Sailed at 14.00 for Lune Deep. Wind increased whilst vessel alongside, and on 29th attained force 8 from N.N.W. At high water the sea was rather rough, and movement was observed on the vessel, ranging about 10 to 12 feet against the bells. No damage was done to either vessel or bells.

M.V. Megara.

28.11.41. Sailed from Lune Deep at 15.00. Berthing operations were carried out in a strong S.E. wind. Sea light. Struck South Bell rather heavily. Bell took full weight giving easily, no jar was felt. No damage to either vessel or bell dolphins.

B. Extract from Appendix 4—Report on Nos. 1, 2 and 3 Borings at Heysham (Extracted from site reports, June 1939).

No. 1 hole—Centre.

Depth.	Formation.
Sea bottom—1-ft. 6-in.	Black sand and silt.
1-ft.6-in.—3-ft. 6-in.	Sand and shell.
3-ft. 6-in.—5-ft. 6-in.	Sand and blue clay.
5-ft. 6-in.—7-ft. 0-in.	Blue clay, sand and peat.
7-ft. 0-in. 11-ft. 0-in.	Blue clay and peat.
11-ft. 0-in.—12-ft. 6-in.	Peat.
12-ft. 6-in.—15-ft. 0-in.	Blue clay.
15-ft. 0-in.—19-ft. 0-in.	,,
19-ft. 0-in.—24-ft. 0-in.	,,
24-ft. 0-in.—25-ft. 6-in.	,,

Hole abandoned at 25-ft. 6-in. owing to damaged and bent casing.

No. 2 hole—North.

Depth.	Formation.
Sea bottom—5-ft. 0-in.	Sand and shell.
5-ft. 0-in. 12-ft. 0-in.	Blue clay.
12-ft. 0-in.—18-ft. 0-in.	Blue clay, sand and peat.
18-ft. 0-in.—19-ft. 0-in.	Sandy clay.
19-ft. 0-in.—25-ft. 0-in.	Clay.
25-ft. 0-in.—28-ft. 0-in.	Sandy clay.
28-ft. 0-in.—30-ft. 0-in.	,,

Note.—Pipe broke off leaving 13-ft. 6-in. in hole 1-ft. 6-in. below sea bottom.

No. 3 hole—South (at 11 a.m., 21.6.39).

Depth.	Formation.
Sea bottom—5-ft. 0-in.	Sand and shell.
5-ft. 0-in.—6-ft. 0-in.	Clay.
6-ft. 0-in.—7-ft. 6-in.	Clay and peat.
7-ft 6-in.—13-ft. 6-in.	Sandy clay.
13-ft. 6-in.—18-ft. 6-in.	Clay (soft).
18-ft. 6-in.—23-ft. 6-in.	Sandy clay.
23-ft. 6-in.—30-ft. 0-in.	,,
30-ft. 0-in.—37-ft. 0-in.	Blue clay.

Hole caving too badly to go deeper.

In withdrawing pipe it broke off leaving a piece 12-ft. 0-in. long—3-ft. 0-in. below sea bottom.

Formation hardened from 21-ft. 0-in.

C. Extracts from Appendix 5—Report on Test Pile Driving.

Southern Dolphin.

Pile driven, 11 July, 1939.

Pile, 50 feet, 14-in. by 14-in., Columbian pine, with driving end tapered and shod with 42-lb. cast-steel shoe 6-in. square and 8½-in. long, with 12-in. by 12-in. pitch pine extension spliced on by two 12-in. by 6-in. pitch pine fish-plates secured by four 1¼-in. bolts. The length of this extension was 20-ft. and was fitted with a heavy driving ring.

The pile was launched in 39-ft. of water, and when in position the full weight of the hammer was set on the pile, which caused a penetration of approximately 1-ft. 6-in.

Driving was then commenced with short blows increasing from 1-ft. to 3-ft., the pile sinking steadily to 7-ft. The 20-ft. extension was then spliced on and driving continued. At 7-ft. ten blows gave penetration of 4-in. to 5-in. At 10 to 11-ft. penetration, 4-ft. blows gave 3-in. penetration; the rate of penetration then decreased slowly to 19-ft. to 19-ft. 6-in., where ten blows gave 1½-in. to 1-in. The penetration on the final thirty blows being as follows: 1-in., ¾-in., and, finally, ½-in., the final penetration, as measured on the pile when extracted, being 21-ft. The weight of the hammer was 2 tons and the drop finally was 4-ft.

Centre of Jetty.

Pile pitched, 14 July, 1939, and finally driven to set 15 July, 1939.

Pile, all as described for the first position, with the exception that 16-ft. extension was used in place of 20-ft.

The Heysham Jetty—continued

50-ft. pile pitched on centre-line of jetty and weight of hammer rested on top causing a penetration of approximately 1-ft. 6-in. Pile then tapped with increasing height of blow to a total penetration of 8-ft.

15 July, 1939. The top of the 50-ft. pile was trimmed of brooming, squared, and the 16-ft. extension spliced on; driving was then continued for a further 1-ft. 6-in. with increasing blows to the full 4-ft. drop.

With the full 4-ft. drop, penetration was then as follows:—

No. of blows.	Penetration: inches.	Remarks.
20	8	Total penetration 9-ft. 6-in.
20	11	
20	8	
20	7	
40	15	
40	13	
40	15	Total penetration 15-ft. 8-in., as found by sounding.
20	$7\frac{1}{2}$	
20	$4\frac{1}{2}$	
20	$4\frac{1}{2}$	
20	$3\frac{1}{2}$	
20	—	Not recorded owing to full blow not being recorded in each case.
20	$2\frac{1}{4}$	
20	$2\frac{1}{4}$	
20	2	
20	—	Not recorded owing to miscount of number of blows.
20	$1\frac{1}{2}$	
20	$1\frac{1}{4}$	
20	$1\frac{1}{2}$	Total penetration 20-ft. 8-in.

Pile at Centre of Southern Dolphin.

After the initial pull with the blocks, which gave a reading of $1\frac{1}{2}$ ton on the Duckham machine, the pull was obtained by the rise of the ship and rose steadily to 6 tons, where it remained steady for a considerable time, after which the load steadily decreased. It is possible that a slightly greater pull than 6 tons was obtained, but not observed by us.

The result of the test, therefore, gave the extraction pull at 14 tons, *i.e.* twice the reading on the Duckham machine of 6 tons plus 2 tons friction—14 tons.

Pile at Centre of Jetty.

Extracted, 15 July, 1939.

After the initial pull on the blocks had brought the load on the pile to $1\frac{1}{2}$ ton, the following observations were taken.

1. Reading of load on the Duckham machine, with time taken.
2. Fall of water-level on pile after maximum pull.

3.—Sounding to show the rise of the tide, with time taken.

Reading.	Time.	Load: tons.	Approx: rise of tide: inches.	Remarks.
		1.5		Depth of water 43-ft. 9-in.
1	7.30	3	5	
2	7.35	5	4	
3	7.40	6	4	
4	7.45	7	$2\frac{1}{4}$	
5	7.48	7.5	$1\frac{1}{2}$	
6	7.50	8	$2\frac{1}{2}$	
7	7.53	7.75	$1\frac{1}{2}$	Pile rose out of water 6-in.
8	7.55	7.5	$1\frac{1}{2}$	Pile rose a further 1-in.
9	7.57	7.25	$2\frac{1}{2}$	See note*.
10	8.00	7	$2\frac{1}{2}$	Pile rose a further 2-in.
11	8.03	6.75	$1\frac{1}{2}$	
12	8.05	6.75	$1\frac{1}{4}$	Pile rose a further 1-in.
13	8.07	6.5	3	
14	8.10	6.5	10	Water-level rose 1-in.
15	8.20	6.25	5	
16	8.25	6	8	
17	8.30	5.5	26	Water-level rose 2-in.
18	8.43	5	8	
19	8.47	4.5	2	Pile rose 1-in.
20	8.48	4.25	4	
21	8.50	4	6	Pile rose a further 4-in.
22	8.53	3.75	2	
23	8.54	3.5	2	Pile rose a further $1\frac{1}{2}$-in.
24	8.55	3.25	2	Pile rose a further $1\frac{1}{2}$-in.
25	8.56	3	6	
26	8.57	2.25		
27	9.00	2		
		1.75		
		1.5		Pile out.

*Note**.—Total pull on pile as shown by reading No. 10 will be 16 tons, *i.e.* twice the reading on the Duckham machine, plus 2 tons friction.

Note 2.—The approximate extraction between every two readings after the maximum load is reached can be taken as the rise in tide, plus or minus the figures shown in the remarks column.

The Marine Department in Port Operation

With Special Reference to the Port of Liverpool

By CAPT. H. V. HART, R.N.R. (Retd.).

The Marine Department is that essential component of a port or harbour organisation which operates the general control of all shipping and all navigational requisites as necessary to ensure the safety of such within the area of the port or harbour. In some cases its operation extends beyond the actual area of the port or harbour itself, and includes the limits of the area of the Pilotage Authority. The port official to whom authority for this responsibility is delegated is variously termed the Harbour Master, Haven Master, Port Captain, Master Attendant, Port Superintendent, etc., according to custom as prevalent in different parts of the world.

Ports may briefly be considered as belonging to within three different categories, according to their geographical situations, viz.:—

(a) Those situated on a river or estuary and having long approach channels, etc., thereto.

(b) Those situated on a river or estuary, or on a seaboard, and having short approach channels thereto.

(c) Those situated on a seaboard and without approach channels.

In (c) the office of Harbour Master, etc., will be sufficient to cope with all duties necessary for the marine operation of such ports. In (a) and (b), which obviously possess greatly extended areas beyond those of (c), the duties and responsibilities of the responsible operating authority are correspondingly increased, and it becomes necessary to invest administrative and operative control, for the entire area of the port, outside the actual docks, in another official. In such case the Harbour Master, etc., becomes responsible for the dock area alone. In Liverpool, which may be accepted as a suitable example of a port within the first category, this official is termed the Marine Surveyor and Water Bailiff. The former title refers to his principal duties, i.e., of making regular and sufficient surveys of the waters of the port to ensure safety to shipping and also to maintain all the requisite navigational aids, in the form of lighthouses, lightships, buoys, lighting, etc. The latter title refers to his authority for control of shipping and operation of the required salvage services. The latter title, too, predates the former, as until **1909** the Water Bailiff's Department was a separate entity, but coming within the authority of the Marine Surveyor, when that office first came into existence in **1846**. The insignia of office of the Water Bailiff, when the Municipal Authorities constituted the Dock Authority, was a silver oar, to be borne in all municipal processions, etc., in the rear of the Lord Mayor. Upon the substitution of the present authority for that of the municipal one, this oar became " adrift " and now forms a decorative appendage to the Lord Mayor's Parlour. It should be here noted, however, that this history of the "filched " oar is hotly contested by the said Municipal Authorities, and an entirely different account of origin is given by them!

The early history of the office of Marine Surveyor of Liverpool dates back to the last century, when a certain Lieut. Denham, R.N., was lent by the Admiralty to Liverpool to make the first complete survey of the port and approaches. Upon completion of that work, which was also responsible for the opening of the existing channel to the Bar Lightship, in place of the old rock channel along the Wirral Coast, Lieut. Denham was appointed as the port's first Marine Surveyor. He served for several years in that capacity and assumed responsibility for all duties as hereafter enumerated, as existed in those days. He finally resigned his appointment as the result of a dispute with his committee as to the provision of a suitable conveyance (horse and cart) for observation purposes of the bay, from the outlying shores. Lieut. Denham returned to Admiralty service and ultimately became an Admiral. Since his retirement from Liverpool, the office of Marine Surveyor has been continuously perpetuated by a number of holders.

In **1909** the two offices of Marine Surveyor and Water Bailiff

The Marine Department in Port Operation—continued

were merged into one, as a logical conclusion, and have thereafter continued as such.

The duties and responsibilities of this office are of an extremely complex nature, and the marine staff is therefore large and varied in composition. Briefly, it consists of:—

- Marine Surveyor and Water Bailiff.
- Assistants (three), of whom two are Seamen and one a Marine Engineer.
- Shore Superintendent and Assistant Superintendent.
- Principal Surveyor and Assistants.
- Chief Draughtsman and Draughtsmen.
- Combined Telegraph, Telephone, R/T and Radar Office Superintendent and Operators.
- Stage Master and Stagemen.
- Superintendent Buoy Stores and Staff.
- Lighthouse and Lightship Personnel.
- Tenders (conservancy vessels), Survey Vessels, Motor-boats, etc., and Staff.
- Wreck Master (salvage) and Assistant, Technicians and Personnel.
- Clerical Staff (General Office).

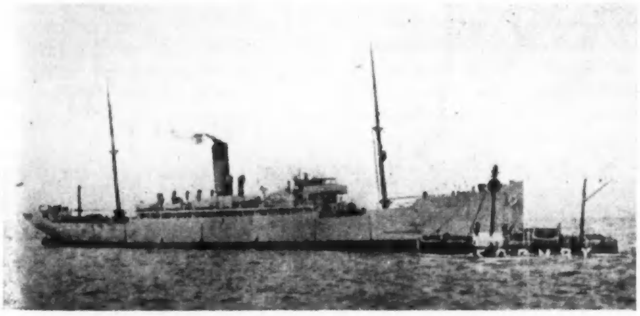
The multifarious duties of the office include the following:—

1.—The control (when necessary) of all shipping traffic within the area of the port and excluding the docks. The proviso is inserted advisedly, as it is the policy to exercise the least possible control, except in cases of emergency, when strict control becomes essential for safety purposes.

2.—Maintenance of all buoyage and lighting within the area of the port. This includes lighthouses, lightships, navigational shore lighting and wreck marking, etc. The total number of lighted buoys approximates to 100, and these require annual change from station for repairs, repainting and renewal of gas (acetylene) containers. Responsibility also rests for continuous correct maintenance of these on station. The lightships are "relieved" fortnightly and the lighthouses are inspected quarterly.

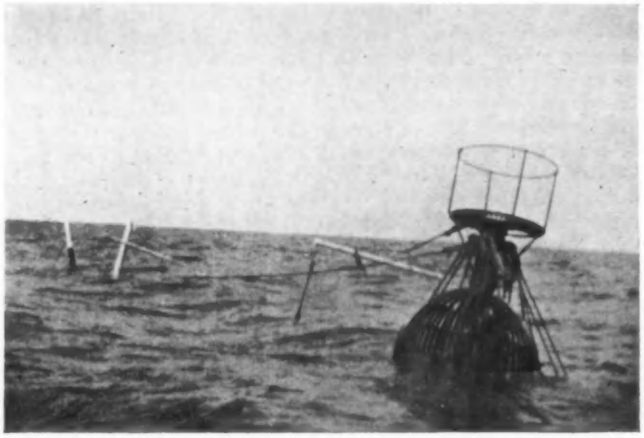
In the majority of U.K. ports the buoyage, etc., is under the authority of one of the three lighting authorities, viz., Trinity House, Northern Light Commissioners, Irish Light Commissioners.

3.—Hydrographical Surveying.—The number and frequency of these surveys are generally established, but naturally vary from time to time, according to circumstances. The entire bay is surveyed annually; the sea channels and other salient features of the bay are surveyed monthly. These latter, in common with most ports of similar geographical features, are subject to considerable



Collision of Steamship with Lightship, from a "Journal of Commerce" photograph taken at the time.

periodic fluctuations, and therefore require constant supervision. Many of the dock entrance river approaches suffer from regular siltation and require surveying at lesser intervals, to the extent of five times weekly in one instance. There are also additional surveys required for special purposes, i.e., previous to launches, etc. All surveys, after completion of plotting and printing, become available for the information of pilots and shipping, within a few hours. If, during an actual survey, any serious discrepancy is discovered, this is conveyed by phone to all those concerned. The whole river and estuary is also surveyed quinquennially, with a view to computation of the changes in estuarial capacities, and their possible reactions upon the régime of the port. Sunken vessels and other obstructions require location and careful surveys made over them and the adjacent area. The echo sounder has proved of great value in the location of under-water obstructions. Numerous other items fall within the category of surveying—surveys of training walls, etc., under construction; the checking of light sectors of lighthouses, etc.; alignment of navigational transit marks; triangulation of new shore navigational marks; establishment and maintenance of marks for the adjustment of



Lightship lying sunk at her moorings, after collision with Steamship. The Lightship was raised five days after the accident.

compasses; maintenance of mechanical automatic tide gauges; operation of "watched" ditto; provision of all tidal data; all these, and many other duties, are included within those of the Surveying Department.

4.—Marine Salvage.—This is an unusual but very essential service and can be considered a valuable amenity, as supplied by a port to its users. During the last decade, and apart from the last war, a large number of vessels and craft of all types would have resulted in loss but for the port's ability to render swift and skilled salvage services. This service is also valuable to the port itself, in providing means of clearing in the shortest possible time dock entrances, berths, channels, etc., of casualties, which have occurred in such places. Successful salvage operations require three essentials:—

(a) Efficient organisation; (b), adequate plant; (c) trained personnel.

Speed in rendering primary salvage service is the keynote to sucecss in many instances and, therefore, any organisation to command success must be in a position to take swift action at all times. This is effected by the maintenance of a 24-hour watch in the Department's Telegraph, etc., Office, which is inter-connected with the General Office, Lighthouses, Lightships, Stages and Tenders by telegraph, telephone and R/T. This office is also equipped with the new and original harbour radar installation at the Gladstone Dock, commanding a view of the entire bay and channels, extending to the bar, and also the greater part of the river. This office acts as the hub of the organisation, and all emergency calls emanate therefrom for the information of the responsible officials concerned, of whom there is a constant "Duty Officer." In the meanwhile, preliminary steps with regard to instructions to tenders, stages, tugs, etc., are taken by the Shore Superintendent, according to the gravity of the situation, and as experience knows to be necessary.

Salvage operations may roughly be divided into three distinct classes, viz.:—

(a) Casualties resulting from collisions, strandings, etc., which require immediate assistance.
(b) Casualties resulting in severe stranding, etc., and which involve more or less protracted salvage operations.
(c) Casualties requiring protracted operations, i.e., removal by raising, etc.

The Marine Department in Port Operation—continued

It may be of interest to note that during the last war the salvage staff of the Port of Liverpool dealt with over 300 marine casualties of all types of craft and of a total tonnage of approximately 600,000 tons. The total values salved amounted to about £8,000,000.

The salvage plant available must be adequate to cope with all emergencies, which are likely to happen in the port. Firstly, this includes tenders specially designed and equipped with everything necessary for the multifarious services for which they are liable. This is difficult to accomplish in a Port Authority's tender, as it must of necessity be of a hybrid nature, as fitted for salvage work—buoyage, surveying, fire-fighting and general conservancy work. Each vessel is self-contained, so as to be able to render all primary services in salvage operations previous to the subsequent reinforcements of additional personnel and plant as may be required. In addition to the normal equipment carried in the tenders, it is necessary to stock a large amount of less readily portable gear, i.e., large size pumps, boilers, generators, compressors, lighting sets, etc. These are stored in various depots, readily accessible and maintained in a state of thorough efficiency by a regular systematic practice of overhaul and rehearsal use. The various items of complete salvage equipment are too numerous to enumerate, and vary from 12-in., 6-ton pumps, to oakum and tallow.

For protracted "raising" operations, lifting vessels known as "Camels" are kept in readiness, at short notice, in handy positions. These are five in number, with a total lifting capacity of 2,000 tons. A large stock of lifting wires, ranging from 9-in. to 6-in. diameter, are kept for use in conjunction with these camels.

The salvage personnel comprises all classes of persons as essential for this service, including engineers, fitters, boiler-makers, burners, shipwrights, divers, riggers, seamen, firemen, etc. All these are under the control of a Wreck Master and assistant, who, on all serious operations, is under the personal direction of one of the senior officials of the department. If it becomes necessary at night, etc., to collect reinforcements of personnel to reinforce that of the tenders, this is effected by means of taxis, with which standing arrangements for such service are in force. In fact, the port provides a 24-hour all the year round emergency salvage service and continuously available at about half-hour's notice.

5.—Fire-Fighting.—This service is provided in conjunction with the local fire authorities to deal with all ships' fires within the port and the approaches thereto, and, if necessary, extending beyond the limits of the port. It is unusual for a municipal authority to possess adequate means of dealing with ship fires outside the docks, and therefore the department's tenders act as a "First Aid" service, and also as a means of transportation for any further necessary reinforcements to the casualty. The port officials are not professional firemen, but they *are* capable of rendering valuable assistance in the preliminary stages of the outbreak. The department's tenders are equipped with modern and efficient fire appliances, including an adequate stock of fire-foam, with larger stocks of this commodity stored in readily accessible positions. The fire authorities are responsible for the extinction of the actual fires, while the department's responsibility consists in ensuring the safety of the vessel concerned as regards stability and removal to a place of greater safety during the operations. In dock fires, the tenders attend upon request of the Fire Brigade and the Marine Surveyor attends all serious outbreaks, as the representative of the port, to ensure that all possible safety measures are adopted. Cordial co-operation and occasional practices with the Fire Brigades are essential to provide efficiency.

6.—Dredging.—This, in Liverpool, as is customary in most ports, is under the control of the Engineering Department. In these cases, therefore, the duties of the Marine Department are limited to the provision of regular surveys where dredging is necessary, or in force, for the correct disposition of dredging plant, and to afford the latest information as to the progress being made.

7.—General Conservancy.—This is a greatly varied duty and one difficult to itemise. Briefly, it may be said to cover general supervision of all matters connected with the marine side of a port, and as pertinent to its régime. Questions of conservancy range from such trivialities as fishing regulations to those of major importance, such as the introduction of training walls, building of dock entrances, or the construction of any works protruding into the river and likely to affect the régime. It may be of interest, and as an example of conservancy duties, to here record an incident which occurred several years ago. One of the department's surveyors brought into the office, as a curiosity, a specimen of grass of an unknown nature, as obtained from the mudbanks of the estuary, where it had grown to a considerable extent. This specimen was forwarded to the Oceanographical Section of the University for identification, and proved to be "Spartina" grass. The report included the opinion that this grass should be at once removed, as it furnished a serious means of reclamation, with ultimate loss of tidal capacity to the estuary, and, as such, might prove a serious menace to the existence of the port. After several experiments, this grass was practically eliminated by the application of sprayed arsenic and saturation with whale oil, at the cost of several thousand pounds.

8.—River Stages.—These are manned by personnel of the Marine Department and are for the use of ocean liners, short passage and excursion steamers, tugs, etc. The several stages are operated by an Officer, who is concerned, in conjunction with the various Shipping Coy's involved, in arranging the berthing of all vessels, arrivals, departures, etc., and the general handling of traffic to ensure the fullest and most efficient use of the stages for all demands. These stages are also used for the disembarkation of cattle.

9.—Harbour Radar.—Liverpool is now equipped with a Harbour Radar Installation which has been specially designed for port use alone, and is quite apart from the ordinary "ship" set. This installation has already been fully described, together with its anticipated uses to the port, in these pages, and therefore no further description is here given. Sufficient to say, that this installation will prove of great service and effect a direct economy to the Port Authority, and prove of assistance to vessels using the port in facilitating their passages in the approaches and in docking under certain conditions of weather, in which delays would otherwise have been experienced. This installation is incorporated with the existing Telegraph, etc., Office, which has been enlarged, with an augmented staff for operation. It is anticipated that in years to come a similar Radar Installation will become a regular feature of every modern port.

10.—Signals, etc.—Arrangements are made with the appropriate authorities for the rapid transmission of weather information for shipping, and suitable sites for exhibition selected. Local signals for the more precise details of weather, and other information, are also exhibited from the lightships. The establishment of leading or transit marks and lights, as necessary for navigating into a dock entrance, or for the purpose of delineation of a special dredged area. All these fall within the province of the Marine Department.

11.—Pilotage.—In some ports it is customary for the Marine Department to operate the pilotage service of the port. In the case of Liverpool, however, this is administered and operated by the separate (pilotage) department, and the Marine Surveyor's responsibilities are confined to acting as Principal Examiner for all pilotage licences and coasting certificates. He also assists in the selection of candidates for the pilotage service. It is customary and also helpful to constantly keep in close touch with the Senior Pilots and discuss with them, and obtain their views, on any prospective major changes in buoyage, etc., which may be anticipated. An item which materially concerns pilotage is the formation of all the local rules with respect to the navigational special requirements for the port. These need periodic revision to coincide with rapid modern developments.

12.—A variety of extraneous duties exist, too comprehensive to enumerate, ranging from the picking up of stray animals (and persons!) in the river, to attendances at the Admiralty Courts and Parliamentary Committees. The department's "Head" is registered as the "owner" of his vessels, and is responsible for any new or acquired tonnage being suitable for all existing and anticipated requirements. All vessels must be operated with the

The Marine Department in Port Operation—continued

maximum economy as consistent with efficiency. It is necessary, too, to keep *au fait* with all modern developments in connection with plant and equipment and carefully decide, before adoption, that any such development or improvement has reached sufficient proved finality to be worthy of adoption. The Marine Surveyor is also a member of the Bidston Observatory Committee, which is jointly composed of Dock Board and University Officials. This Observatory is now principally concerned with the calculation of tidal data for most ports of the world. The long established and now antiquated time gun, at 1 p.m. each day, is still electrically operated from one of the stages by the Observatory. Supervision over all moorings laid and occupied by fishermen, yacht owners, etc., is necessary to ensure that such moorings do not infringe upon navigable waters and are laid in recognised areas only.

In previous times, and during the period of withdrawal of the motor lifeboat for overhaul, it became occasionally necessary for one of the department's tenders to tow out the substitute sail lifeboat to the scene of the casualty in heavy adverse gales.

An amusing incident, as exemplifying the diverse nature of duties, occurred one night, when assistance was summoned to deal with a bull which had broken away on one of the stages and had become jammed in the doorway of a lavatory, occupied by an unfortunate man, who was thus closely contained, without room for retreat, within a space of about 2 feet from the enraged animal's head. "Purchases," etc., proving insufficient to shift the bull, necessitated the removal of a portion of the roof to release the frantic inmate!

There is another activity of the Marine Department in the operation of short day cruises in the Board's Publicity Vessel. This vessel is lavishly equipped and able to carry nearly 100 persons, in the form of actual and potential clients of the Board. The usual trips made were through portions of the docks, the river and bay, and lunches, teas and dinners were served on these occasions.

It is hoped that enough has been recorded to indicate most of the duties and responsibilities of the Marine Department of a large port. It may also be recorded that, in the last two wars, the Marine Surveyor, in addition to the ordinary duties, was appointed ex-officio, by the Admiralty, as Chief Examining Officer of the port and also of all local ports within the district, under the command of the local Flag Officer. This was, of course, the logical conclusion to effect co-ordination between coincident naval and civilian duties, as affecting the general marine side of the port.

Health Administration at British Ports

By H. C. MAURICE WILLIAMS, O.B.E., M.R.C.S., L.R.C.P., D.P.H.*

The present-day practice of port health control is so regulated that it causes a minimum of interference with passengers and cargo traffic, yet provides safeguards against the importation of the major infectious diseases into the country.

The changes in quarantine practice in this country throughout the centuries illustrates the altering scientific conception of the way in which infectious conditions are transmitted.

Early Quarantine Regulations

The term "Quarantine" owes its origin to the forty days' detention of ships which was first enforced by the Venetians in the fourteenth century as a precaution against plague, and so great was the fear of that scourge that, both in that country and others, infected ships are known to have been sunk or set on fire in a determination to stamp out the risk of infection.

Great Britain, with her important maritime ramifications and commercial interests, was quick to follow the example of Venice by applying stringent penalties for any infringement of the regulations governing the control of infectious diseases. As long ago as 1664, the King in Council enacted that no vessel might approach London nearer than Gravesend or such like distance. Lazarettos were appointed for the reception of ships' cargoes, which had to be aired for forty days, and guards were appointed to prevent any communication with the shore.

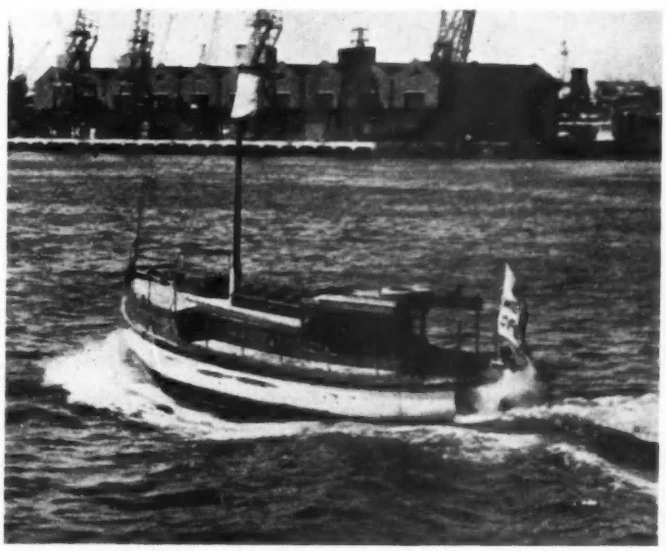
However, these rigorous measures were totally ineffective, for it is recorded in Sir John Simon's classical work "The English Sanitary Institutions" where he states: "Endeavours to exclude by quarantine the contagion of plague were as ineffectual as if their intention had been to bar out the East Wind or the New Moon," for London, in the year 1665 it will be remembered, was visited by the Great Plague.

Nevertheless, the practice was adhered to for many years, and it was not until 1825 that the last Quarantine Act was passed in this country, and this still provided for strict quarantine for vessels which had come from places where plague or "highly dangerous distemper" was prevalent.

This Act was finally repealed in 1896. Twenty-four years earlier the Local Government Board had constituted Port Sanitary Authorities, whose duties were to enforce the necessary measures for safeguarding the ports. Port Health Authorities, as they are now called in accordance with the Port Health Regulations of 1933-45, are still the statutory bodies that carry out the day-to-day work of this control.

Modern Statutory Obligations

Under the Port Health Regulations, 1933-45—the title of the Regulations having been altered from Sanitary to Health by the 1945 Amendment—there is a statutory obligation on the master of a foreign-going ship arriving at a British port to ascertain the state of health of all on board. He must enter this information in a detailed questionnaire and this must be delivered either to the Customs Officer or to the Officer of the Health Authority at the port of arrival. This written "Declaration of Health" must be signed by the Master, and countersigned by the Surgeon, if one is carried. The contents of the document enable the Port Medical Officer to take without delay such remedial action as may be necessary.



Launch used by Port Medical Officer for boarding vessels.

In order to reduce delay to a minimum the United States of America have recently introduced radio practique. This system, however, is confined to such ships as carry surgeons of proved experience, whose duty it is to wireless information as to the state of health on board twenty-four hours before arrival. Where the

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Health Administration at British Ports—continued

information contained in the message satisfies the Quarantine Officials, the ship is permitted to dock without further delay.

Other countries are likely to adopt a similar procedure if the United States' experiment proves to be effective after a trial period.

So far as this country is concerned, certain ports designated in the London Gazette are in a position to receive radio advice from the Masters of foreign-going ships possessing the necessary transmitting apparatus, where any person on board shows symptoms which may be indicative of infectious disease (other than tuberculosis), or if there are any circumstances requiring the attention of the Medical Officer. These messages should be sent so as to reach the Port Health Authority not more than twelve, and not less than four, hours before the ship's arrival.

International Code of Signals

Most of these messages are transmitted in accordance with the International Code of Signals, and local experience has shown the value of the system, particularly in so far as it enables advance preparations to be made for any major condition on board.

A Smallpox patient being landed from a Military Transport.

The use of relevant flags and signals is also an obligation upon the Master of a foreign-going ship when his vessel is infected or suspected, and comes within three miles of the British coast.

The flag signal " Q " (plain yellow square)—the yellow jack—has for centuries been associated with Yellow Fever or the presence of other infection on board, but under the new Regulations its meaning has been altered to " My ship is healthy and I request free pratique."

Further flag signals used in connection with the arrival of vessels are " QQ," which means " My ship is suspect," or that is to say, " I have had a case or cases of infectious disease more than five days ago, or there is an increased mortality amongst rats on board."

The flying of the double flag signal " QL " (" L " is a quartered flag of yellow and black) indicates " My ship is infected " or " I have had a case of infectious disease during the last five days."

Between sunset and sunrise, a signal consisting of a red light over a white light not more than six feet apart means " I have not free pratique."

Another innovation introduced by the 1933 Regulations is the obligatory establishment of Mooring Stations. It is laid down in the Regulations that the Port Health Authority, after consultation and agreement with the Customs and Harbour Master, must designate certain areas for use as Mooring Stations for vessels requiring detention.

An Outer Mooring Station is chosen outside the dock area, whereas the Inner Mooring Station is selected within the precincts of the docks, or may on occasions be the usual berth of the vessel when the Medical Officer decides that this position is the most suitable for berthing.

Present Day Procedure

When a ship arrives from a foreign port and it appears to the Customs Officer, from the answers given to the various questions asked for in the " Declaration of Health," that a death or case has occurred during the voyage, or during the last six weeks of the voyage which is suspected or known to have been caused by an illness of an infectious nature, he is obliged to direct the ship to a Mooring Station, where it is detained until inspected by the Port Medical Officer.

A similar procedure is adopted in respect of ships that have called at one or more infected ports, these being ports at which one or more cases of plague, cholera or yellow fever have occurred, or ports or seaboards where louse typhus or smallpox have recently occurred in epidemic form.

This list of infected ports must be kept up-to-date by the Port Medical Officer from information he receives in the weekly Epidemiological Record.

The detention of the ship by the Customs Officer can only last up to the time of the Medical Officer's visit, or for a maximum period of twelve hours. But where the Medical Officer so decides, a ship may be detained for such longer period as is required to carry out the prescribed measures.

Since the war most of the larger ports of this country have had occasion to deal with cases of smallpox, most of these cases having occurred on transports from India. In dealing with such cases, the usual procedure is for a wireless message to be sent to the Port Health Authority, giving information about the case or cases, with details of onset, rash, etc., following which a reply is sent to the Master by the Port Medical Officer detailing the place of mooring, instructions relating to the preparation of names and addresses of all passengers and crew, advice regarding vaccination, and the provision of accommodation for the examination of passengers and crew.

When the vessel anchors at the Mooring Station she is boarded by the Port Medical Officer, with his staff of Medical Officers, Port Health Inspectors and Nurses.

In the case of smallpox, the following procedure must be carried out in accordance with the Fourth Schedule of the Regulations:—

(a) All persons on board must be medically examined.
(b) The sick must be immediately disembarked and isolated.
(c) Any person reasonably suspected by the Port Medical Officer to have been exposed to infection is offered vaccination, unless, in the opinion of the Medical Officer, the person is sufficiently protected by previous vaccination or a recent attack of smallpox.
(d) Every such person must then be placed under surveillance for a period not exceeding fourteen days after the date of arrival of the ship.
(e) Bedding which has been used, soiled linen, wearing apparel, and any other article which the Medical Officer considers to have been recently infected must be disinfected.
(f) Parts of the ship which have been occupied by the person suffering from smallpox, or which the Medical Officer considers to be infected, must also be disinfected.

In the case of the other four major diseases a somewhat similar procedure to that described for smallpox is carried out, with certain additional measures for each of these specific diseases.

For instance, with a case of plague or a mortality amongst rodents on board, the ship may have to be deratised before any cargo is discharged.

Health Administration at British Ports—continued

Contracts must be kept under surveillance for six days from the date of arrival.

In the case of cholera the drinking water stored on board in tanks may be emptied after it has been disinfected, and replaced after disinfection of the tanks and filters, by a supply of wholesome drinking water.

The Medical Officer may prohibit the emptying of water ballast until after it is disinfected, if it was taken on board from an infected port.

Further, he may require the waste water of the ship to be disinfected before it is discharged from the ship in case it contains any human dejecta.

With regard to typhus, any part of the ship which has been occupied by a person suffering from typhus must be disinfected, and any person reasonably suspected of harbouring lice, or of having been exposed to infection must be deloused, and may be placed under surveillance for a period not exceeding twelve days from the date of delousing.

The only vessels which are exempted from the provisions of the Regulations are those ships employed in H.M. Service and ships belonging to foreign governments.

If any person refuses or wilfully neglects to obey these Regulations he is liable to a penalty not exceeding £100, and in the case of a continuing offence, to a further penalty not exceeding £50 for every day on which the offence continues.

Regulations Regarding Marine Airports

During recent years additional onerous duties have fallen on Port Health Authorities in connection with the importation of infectious diseases from aircraft landing at marine airports. The epidemiologists are faced with the problem of dealing with this question, which is vital in the interests of both national and world health.

In the past our maritime frontiers have been valuable bulwarks against the introduction of the major infections, but now this advantage has disappeared by the speed of air travel whereby a passenger by air can fly from Singapore to London in two days, and from India or South Africa in 36 hours. This is much shorter than the normal incubation period of plague, cholera, yellow fever, typhus and smallpox, the diseases with which international control is mainly concerned.

Fortunately, yellow fever is unlikely to occasion any great threat to this country, because Britain's climatic and environmental conditions are not conducive to the survival of the vector mosquito.

Regarding cholera, the chances of the disease spreading in this country are also very remote, because of the high standard of our water supplies and our efficient sewage disposal schemes in urban areas.

In connection with plague, there is much less likelihood of rats being transported on aircraft because of the lack of harbourage as compared with ships, but the dangers of infected rodents cannot be lost sight of.

The two main diseases with which we are concerned are smallpox and typhus.

In order to conform with the International Sanitary Conventions articles first drawn up in 1933, and later amended in 1944, the Minister of Health has issued further Regulations designated The Public Health Aircraft Regulations, 1948, which came into force on the 1st April. These replace the former Regulations in connection with this matter, which were issued in 1938.

The procedure laid down in the Regulations is that all incoming aircraft from infected places abroad must be met by a medical officer. On arrival the Commander of the aircraft will report the state of health on board in a written statement similar to the Declaration of Health submitted by masters of vessels. The passengers also sign a personal Declaration of Health, giving information about their various inoculations and the names of places at which they have been for the last fourteen days. Passengers showing no symptoms of any infectious disease will be given a card giving simple precautions which they should observe if they fall ill within the next twenty-one days. These include the showing of the card to their doctor, who is thus made aware that the person has recently arrived from abroad, where he or she may have been exposed to infection.

The private doctor is asked on the card, if he is in any doubt about the illness, to inform the Medical Officer of Health for the district. The purpose of this is that all cases of illness in travellers arriving by air from abroad can be traced and the local Medical Officer of Health can take any necessary precautions, including isolations of the sick and the supervision of contracts.

Aircraft flying between England and Wales, Scotland, Northern Ireland, the Channel Isles and the Isle of Man will not be subject to the Regulations.

In Southampton, the British European Airways Corporation have recently established a marine airport, and one can visualise that these additional duties will add a great deal of responsibility to the work of the Port Health Authority.

The Goodwin Sands

A Geological and Historical Survey

In view of the number of strandings on the Goodwin Sands since the war, the history of the hazard is a subject of constant interest, and the following account is taken from a bulletin recently issued by the Admiralty:

These shoals off the East Coast of Kent have a bad name connected with accidents at sea, and although it was probably justified during several hundred years of sailing ships, it is not altogether true in the present day.

A list, compiled from Lloyd's records, shows that excluding the war period from September 3rd, 1939, to March 8th, 1945, 24 vessels have stranded on the Goodwin Sands from January 1st, 1930, to March 29th, 1948. The worst year appears to have been 1946, though the reason for this would be difficult to assess. It may be partly due to the first year after the war, when ships were no longer guided in convoy, and with their war experience perhaps their captains felt there was no need to incur the expense of a pilot, which is normal in these tricky waters. It is significant that no large passenger liners are concerned.

London, being a major port where the density of shipping is very great, will have its percentage of marine accidents; not forgetting that the Thames area has experienced two wars. About 40 ships a day pass the Goodwins, and the risk of being wrecked on them is less than 1 in 10,000. There appear, however, to be three main types of grounding on the Goodwin Sands, which are borne out by records of similar types in the last century in sail.

On the north-western edge of the Sands abreast the inner passage, known as the Gull Stream, there are a few groundings. The edge of this bank has always been well marked by buoys, and the reason that ships get too far to the east may be that in fog or blinding snow storms, the buoys and their lights may not be seen. In clearer weather other deep draught shipping acting selfishly in the narrow channel, may force a Mariner to manœuvre too close to the bank, where the tidal streams tend to set onto and over the Sands, particularly at high water when they are most dangerous, as they are covered and cannot be seen.

It will also be noticed that a few ships ground on the inside of the Sands in the north of Trinity Bay. This can be read as a gross error of navigation; navigating, without fixing, on too small a scale chart; very thick weather blotting out all marks, lights and buoys after rounding the South Foreland; or vessels keeping wide of ships anchored and manœuvring in the Downs and failing to sight the buoys. It must be realised that though a chart is a model of clarity, the situation in the sea, in a strange place, is often very confusing, especially at night.

The moral to be drawn from both the above types of grounding, is that a pilot, with local experience, should be used by ships proceeding through the Downs. No ship has been wrecked on the Goodwins with a pilot aboard for 30 years.

Lastly, it will be apparent that the majority of the ships are wrecked on the eastern or outside edge of the Sands. The reason

Goodwin Sands—continued

for this is very probably that ships proceeding from North European Ports through the Straits of Dover and down the Channel shape their course to pass within sight of the South Foreland, at about 10 miles, and that they fail to make the necessary allowance for the strong tidal streams, up to $3\frac{1}{2}$ knots, that are likely to set across their course. This is borne out by the sparse information as to the voyages of the majority of these wrecks, such as Hamburg to Boston, etc., and at least two accounts from Masters who expressed surprise at being set so far out of their intended track. Although the outer edge of the Sands are well buoyed, on occasions the visibility is reduced to a few hundred yards by fog, rain or snow. The moral here is that Mariners, who are used to coasts where the tidal stream has little or no navigational effect, must apply the particular type of navigation required in waters affected by strong tidal streams, and should study and use the largest scale British charts on which the tidal stream tables and latest information generally are given (charts of other countries of this area are small in scale); "The Atlas of Tidal Streams, 1943"; "The Channel Pilot, Part I, 1947"; "Tidal Streams of the Waters Surrounding the British Isles, 1945"; all of which hydrographic publications cost a few shillings in comparison with the thousands of pounds of valuable ships and cargoes, and are available to Mariners of all nations from chart agents. Furthermore vessels who estimate that they are approaching the eastern or south-eastern part of the Goodwins, in thick weather, should keep outside 20 fathoms by their echo-sounding machines, until they have verified their position by the light buoys or the more powerful 11 mile lights on the E. or S. Goodwin Light Vessels; if a ship is seen running too close the Light Vessels fire a warning gun. A coxswain of the Walmer Lifeboat, 47 years in the service who remembers clinging to the rigging of the "Cape Lopez" wrecked 40 years ago when the sailing lifeboat broke loose, reckons that most Goodwin casualties are due to "just bad navigation."

Geology.

In the "Geology of Ramsgate and Dover," it is implied that the main body of the Goodwin Sands have a tendency to drift to the S.S.W., as this evidence appears to have been obtained from the Admiralty charts, it is possible that a mistaken interpretation has been made of the banking up of sand on the South Sand Head, before it is shifted on, probably to the N.N.E. The chart of Elizabethan times which is quoted as showing the southern tip a mile further north, cannot, on inspection, be relied on for so much accuracy.

A comparison of the charts from 1795 to 1948 will show that there has been little shift in the main body of the sand, though large portions have considerably altered from time to time. The fact that there is a current of 3 miles a day to the N.N.E., apart from the tidal streams which ebb and flow equally, and the hollow horseshoe shape, steep on east, north and north-western sides, but shelving more gently in Trinity Bay, gives the impression that the main part of the sand is being drifted over the shoals toward the N.N.E. The channel now known as "Kellet Gut," though it should not be used by ships, is interesting. There was a similar channel in 1795, though a little further south, and running more nearly east and west, called the "Hearst Gulf." In 1583 a similar division of the Goodwin Sands is shown named the "Swatch." By 1846 this passage was silted right across and stayed so, certainly up to 1896, although remains of it were apparent in slight bends of the fathom contours. During the same period a channel slowly broke through and widened and deepened in the North Sand Head, but has now closed up, in the last 50 years or so, when the Kellet Gut has opened again. This latter represents the movement of about 100 million tons of sand.

Such a break through in the opposite direction to the above apparent main drift to the N.N.E., is probably due to the ebb tidal stream, possibly started by a series of particularly violent northerly winter gales. This spoon-shaped shoaling, as with the main body of the sands, with smaller spoon-shaped breaks from the opposite stream, was apparent in another area of altering sand shoals. Mud being more glutinous, does not behave in the same way, but lies flatter. On the other hand there is reason to suspect that shingle, or a mixture of sand and shingle collects into long thin ridges lying in the main directions of the tidal streams or currents, such as the Varne, Le Colbert, South and North Falls and possibly Sandettie Bank, all near the Dover Straits. The evidence, however, is scanty, and though the origin and movement of shoals and important channels is the cause of much headache and labour to port authorities all over the world, and expense in surveying, dredging, buoying, pilotage and casualties, little is known of this aspect of hydrology-geology.

The disappearance of the shoal known as the "Bunt Head," 1846, on the east side should be noted, and the alternate shoaling and deepening of the Goodwin Knoll on the north. Surveys of the channels used by ships are carried out at frequent intervals of course.

Owing to the frequent and rapid disappearance of wrecks on the Goodwin Sands, the term quick sand has often erroneously been applied to them. When they uncover at about half tide, however, one can walk about on them with safety, though there may be many pools and runnels crossing them, waist deep, which can be waded. On a number of occasions cricket matches have been played on the sands, the first in 1824.

Until 1849 it was thought that the sand extended to a depth of about 15-ft. only and rested on a clay or chalk ridge. Admiral Beaufort found he could only force a steel bar to 8-ft. with a sledge hammer. Captain Bullock, R.N., the constructor of the first "Safety Beacon" ever erected on the Goodwins, in 1840, found the sand at $7\frac{1}{2}$-ft. so dense and cohesive that his boring screws were twisted and broken in the efforts to make them penetrate lower. Further, he found that a 3-in. diameter iron rod at a depth of 13-ft., took 46 blows with 1-cwt. drop hammer, with a 10-ft. fall, to drive it down 1-in.

Sir H. Pelly, Deputy Master of Trinity House, in 1849, made a boring with a $2\frac{1}{2}$-ft. diameter pipe sunk in 10 lengths, until it reached solid chalk at 78-ft. Bright sand was found down to 46-ft. and then various layers of sand mixed with broken shell, nodules of chalk and clay, and a layer of decayed wood and seacoal at 67-ft. No firm foundation for the erection of a lighthouse or other structure was found till the solid chalk. Even if any construction could be founded in the chalk, and its cost would be prohibitive, the strains that might be imposed on it by a shift of the sand, such as the Kellet Gut, would make its safety most uncertain. Mr. Walker found solid layers, reported as clay (?), at 57-ft. at North Sand Head, 49-ft. further south, and 78-ft. at South Sand Head.

The method of sinking the pipe, is to withdraw the air with a powerful pump, when the sand, shingle or mud will flow up the tube, and the rush of water, from below undermines the lower edges of the tube, which then descends by its own weight and the pressure of the atmosphere on its upper end.

A simpler method for feeling for hard layers or driving temporary beacons may be mentioned here, as it is easy to use from a ship at anchor and is often employed by dredging engineers for "pricking" the bottom of a channel. A 2-in. gas pipe, screwed together in lengths, is hoisted out by a derrick. The pipe is connected by a hose and a screw-on-adapter to the ship's fire main, and water at a fair pressure is pumped down the pipe which undermines the end in the sand, and, lowered by a tackle, sinks by its own weight. If a harder, but not too large, lump of clay or coral is met, the pipe can be raised and dropped a few feet to hammer its way through. It does not, of course, recover samples at different layers, but it does permit an estimate of the seabed for dredging or construction.

Many varied schemes in connection with the Goodwins, have been submitted in the past, from the humble erection of beacons, lighthouses and forts to the building of a huge harbour of refuge, docks, breakwaters and the reclamation of a large island for cultivation, buried treasure from wrecks, and the profit of the shareholders.

A number of famous people have entered the lists including the Duke of Wellington, for a defensive fort; Admiral Cochrane, with the novel idea of binding the sand together with Trinidad asphalt for a lighthouse; Stevenson's rubble cone for a lighthouse, similar to the foundations of Portland and Plymouth breakwaters built on sand, but forgetting that the sands on the Goodwins are liable

Goodwin Sands—continued

to move, where the others do not; Smeaton, the designer of the famous Eddystone Lighthouse off Plymouth, who, it may be recalled, lost his life when the lighthouse was washed away in a severe storm, which he particularly wished to observe, so certain was he that his lighthouse would stand up to anything. The Goodwins have been the subject of questions in Parliament, and enquiry by Parliamentary Committee.

It may be mentioned that there is no particular evidence near the Goodwins of where the Thames was supposed to have joined with the Rhine to flow through the Straits of Dover down the channel out to the Atlantic, in ancient times, though the Hurd Deep, a long narrow trench in the seabed, off Cherbourg, is supposed to have been part of such a river.

The present hydrographer, Admiral A. G. N. Wyatt, C.B., while sounding over the Goodwins, as a young lieutenant, found himself in difficulties with a falling tide, a broken-down engine, an anchor that would not hold, and being driven further aground by the breakers and tidal stream. By putting a spring on the cable from the stern to kite the vessel across the tidal stream, the forces tending to increase the danger, were employed to drive the vessel sideways off the Sands, there being sufficient pull from the anchor although it was dragging. Even without a Spring, the dragging anchor was sufficient to bring the bow up partly causing a kiting action, instead of driving broadside on. The method will no doubt commend itself to others in similar trouble.

The present Superintendent of Charts, Captain E. H. B. Baker, D.S.O., R.N., who found the Kellet Gut in 1936, steamed his ship through it, fixing by shore marks, a matter of some anxiety in the poor visibility and haze that predominates on this coast.

Historical

The earliest chart which shows the Goodwin Sands in sufficient size for navigation, with soundings around it, is that in the Atlas of North European Charts, drawn by Lucas J. Waghenaer, a Dutchman, in 1583, and copied five years later by Anthony Ashley. Such collections of charts bound in one volume, were known as "Waghenaers" for about a century after.

There are various legends connecting the Goodwin Sands with Godwine the Saxon Earl of Kent, each remarkable for a sort of stern retributive justice and exposing a certain amount of political intrigue. One story says that Godwine was owner of a great quantity of flat lands defended from the sea by a great wall, which lands passed to Harold II his son, and afterwards were bestowed by William the Conqueror on the See of Canterbury, who being set upon building the steeple at Tenterden misapplied the stone and timber materials intended for the maintenance of the dyke. On the 3rd November, 1099, a great storm arose and the sea broke over and drowned the lands overwhelming them with a light sand, and the place thereby obtained the name of Goodwin Sands, and thus Tenterden Steeple is said to be their cause.

This story is not improbable except in its last stages, when it might be presumed that the local inhabitants thought the sand came from the Goodwin shoals, and were more likely to have inundated Sandwich Haven which is known to have been a wide harbour in Roman times, and to have gradually filled in the course of centuries.

In Roman times Sandwich Haven was a great port and one of the principal ones for entry to this country from the Continent. The Roman Castle at Richborough (Rutupiæ) still stands, and ships proceeded to the Thames by the waterway, the Portus Rutupinus, which made Thanet an Island, from Sandwich via the lower Stour and Wantsum Rivers to the North Kent Coast at Reculver (Regulbium). Harold's fleet used it, and a monastic map of the Isle of Thanet, circa. 1414, shows a considerable width. The Venerable Bede (A.D. 735) states that it was 625 yards wide, but fordable in two places, but he omits to mention whether this width was at its mouth or its narrowest, and though many historians have argued considerable earth movements to account for the practical closing of this route and the height of the valley, now 19-ft. above high water, it does not appear that they lay much stress on the small size of ships of those days.

Certainly it was a well-used water route and Sandwich was a wide open harbour. Moore's Ancient Witness claimed to have seen sizeable vessels in it, though it was not in use at the time of the enquiry. At Sarre, a village near the junction of these rivers, ancient anchors and timbers for piers have been unearthed, but the route may have been little better than the present rivers slightly wider. Early writers dscribe three islands, Tanatus (Thanet, Teneth, from a fire beacon on the cliff), Rutupiæ or Ruochini Insula (Richborough), and Inferna Insula (or Low Island). Some latter-day writers argue that this was Lomea I on the present site of the Goodwins, but it seems equally likely that it may have been an isolated part of Stonor beach or another bank near Sandwich. If it did possibly refer to the Goodwins, it is unlikely that in those days, they drew the present sharp hydrographic distinction between an Island, which is always above high water, and a Drying Bank that covers and uncovers with the tide.

Miscellaneous

The Nore, the well-known headland on the North-East Coast of Thanet, derives from the word Nower (Nour), which is shown on a chart of 1703, which has been traced to a local term for a parkland near Dorking, Surrey, where the Earl of Godwine also had estates.

The Navy used the Downs as a sheltered anchorage for fleets from the 16th to 19th Century, and Commander-in-Chief of the Nore is the title of the Admiral Commanding the Thames Estuary, and Chatham and Sheerness Naval Ports to this day.

The Downs, from the Saxon "dune," a shelter, between the Kent Coast and the Goodwins is protected by the latter, but in the "great storm" of the 26th November, 1703, a whole fleet of thirteen ships under the Command of Admiral Beaumont were lost, four at least, having parted their cables were driven on to the Goodwins. Many remarkable stories exist of the rescue work carried out by the Lifeboats of Ramsgate, Walmer, Deal and Dover.

So much play in the past has been made with "the horrible swallowing quicksand" nature of the Goodwin Sands, that questions continue to be raised on this. A true quicksand is a mixture of sand and water, usually in a fairly small patch, where the water is unable to drain away, probably because of an underlying pocket of rock. The surface is flush with the surrounding sand and no different in colour, unless the light reflection off the slightly watery surface is in the right direction. It will not bear a man's weight and he will rapidly sink into it, without being able to withdraw unless he is near near the edge or has help. Small ones may be found between Cuckmere and Seaford on the Sussex Coast, and many other parts.

The action on the Goodwins is more that a vessel wrecked on it may pound heavily with the breakers in such an exposed position, and rapidly break up. Further, that with every tide the top foot or so of sand is moved by the tidal streams, and in several weeks, perhaps several feet may be so removed. One has only to stand in the wash of breakers on a steep sandy shore to appreciate the action of how the sand covers ones feet with a few inches of sand on the upwash, and the sucking action on the backwash that removes the sand on one side. This sort of mechanical action due to the flow of water over the surface of sand is not peculiar to the Goodwins, but is applicable everywhere, and explains why ships' anchors in the Yangtzse River are buried and cannot be weighed unless they are sighted every two or three days.

Hasted (1799) quotes a Mr. Boys, of Sandwich that, "the Goodwins are of the same nature and hardness as the sandy shore in Sandwich Bay, and that by motion you can work your feet into it up to the ankles only, and with iron borers it can be penetrated to about 3½-ft. only. The idea of its swallowing up vessels is false. Everything that strikes upon it breaks to pieces at once, or the bottom of the vessels by agitation, sink into the sand and the upper parts are broken by the waves." Mr. Boys appears to have been a sensible and practical observer.

In this connection it is interesting to note that the Tongue Sand Tower, about 14 miles north-west of the Goodwins, which is a large iron and concrete structure, floated out and sunk on to the surface of the sand during the war for anti-aircraft defence, has in 1947 capsized to 15°, through the scour of the sand at its base.

Notes of the Month

Lights on Greenland Coast.

It is announced from Copenhagen that during the next two years 23 new automatic lights are to be installed on the west coast of Greenland, at an estimated total cost of about 500,000k. The Danish Directorate of Lights is at present engaged on repair and reconstruction work at the Faroe Islands, estimated to cost about 750,000k. The most important undertaking is the rebuilding of Lodso Light, the largest in the islands, on which the Germans scored a direct hit during the recent war.

Combating Pilferage at Finnish Ports.

A new company has been formed in Helsingfors by insurance companies, shipowners, stevedores, brokers and forwarders, in close co-operation with the police and harbour authorities, for the purpose of guarding ships in Finnish harbours against pilferage and for increasing the effectiveness of the present system of policing both ports and ships. For the time being the company will concentrate mainly on the Port of Helsingfors, but later it will extend its services to ports throughout Finland.

Port Traffic of Great Britain and the United States.

According to statistics recently issued by the United Nations' Headquarters at Lake Success, the United States and Great Britain handle most port traffic, followed by Holland, Belgium and Sweden. Traffic handled at French and Canadian ports has declined sharply since before the war. The latest available figures show that 4,587,000 tons of shipping entered United States ports during May, compared with a monthly average of 3,991,000 tons in 1938. In the same month, British ports handled 4,393,000 tons of shipping against a 1938 monthly average of 5,698,000 tons.

Proposed Baltic Sea Rescue Service.

The Swedish Life-saving Society has recently opened negotiations with the Finnish authorities in Helsinki in connection with the establishment of a projected marine rescue safety chain along the entire coastline of the Baltic, the Kattegat and the Skagerrak. Denmark, Norway, Poland and the Western Zones of Germany have already indicated their interest in the project, but so far the Soviet Union have not notified their approval. Appropriations are awaited to commence construction of a new fleet of lifeboats. They will be 45-ft. vessels with a speed of 34 knots and accommodation for 65 persons, including 16 berths.

Dry Docking at Cape Town Harbour.

It was recently announced in Cape Town that the steel docking towers, which are to be used in the Sturrock graving dock to enable small craft to be docked two abreast, have now been completed and are ready for installation in the dock. These towers should have been completed some months ago for use in connection with the whale catchers and owing to the delay the Administration have had to make use of temporary cement caissons instead.

Official Approval of Marine Radar Equipment.

Marine Instruments, Ltd., announce that the Kelvin-Hughes marine radar, type 1, has now been granted an official type approval certificate of the Ministry of Transport. Many vessels have already been fitted with Kelvin-Hughes radar sets, which comply fully with the stringent specifications laid down by the Ministry of Transport and are governed by the certificate now issued.

Messrs. Cossor Radar, Ltd., also have received official type approval for their Mark 1A, 4-range equipment. The certificate of approval was issued by the Ministry of Transport in collaboration with the Admiralty Signal and Radar Establishment, Portsmouth. The equipment is provided with four separate ranges covering one mile, three miles, 12 miles and 30 miles. A standard second-class buoy can be picked up at a range of nine miles.

Increased Traffic at the Port of Gdynia.

The Polish Ministry of Shipping announce that more than 8,000,000 tons of shipping have already passed through the Port of Gdynia this year, twice as much as the corresponding period of last year.

Trade at the Port of Liverpool.

According to figures recently issued by the Mersey Docks and Harbour Board, the Port of Liverpool handled over 1,100,000 tons more cargo in the year ended July 1st than in the previous 12 months. The total tonnage during the year was 10,592,678 tons, comprising 7,673,501 tons imports and 2,919,177 tons exports. The respective figures for the year ended July 1st, 1947, were 9,439,010 tons total cargo, imports being 6,620,984 tons and exports 2,818,026 tons.

New Port for the Philippine Islands.

The new port of San Fernando, La Union, Philippine Islands, was formally opened early last month. It is hoped that the cost of goods in northern Luzon will be appreciably reduced by unloading cargoes at the new port, as hitherto overland transportation from Manila has been an expensive item. San Fernando is a natural harbour that has been considerably improved by the United States Army and Navy during recent years. It will be the fourth port of the islands, the other three, in order of importance, being Manila, Cebu and Iloilo.

Development of the Port of Houston.

The Port of Houston, U.S.A., plans to spend $32,000,000 (about £8,000,000) on expanding its facilities. In the first six months of this year, the cargo handled at the port showed a 23% increase in tonnage, the total being 19,996,093 tons, compared with 16,195,830 tons for the corresponding period last year. Plans for the construction of seven new wharves have been approved and a contract has already been given for the first of these, to cost $1,734,693 (about £433,673). The expansion programme also includes the widening and deepening of the Houston ship channel for a distance of 25 miles.